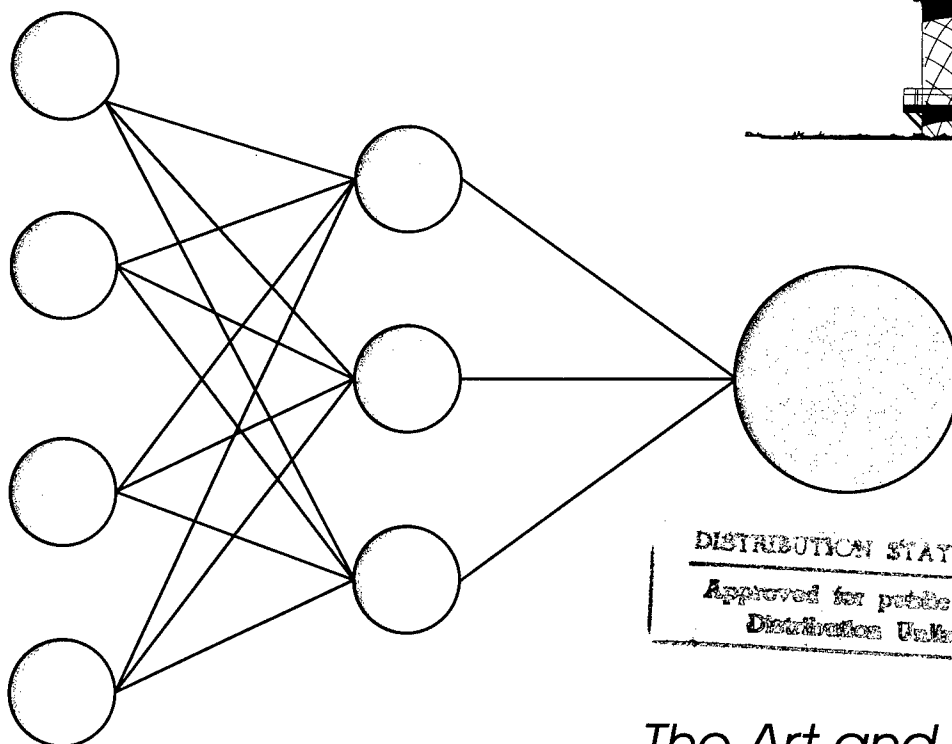
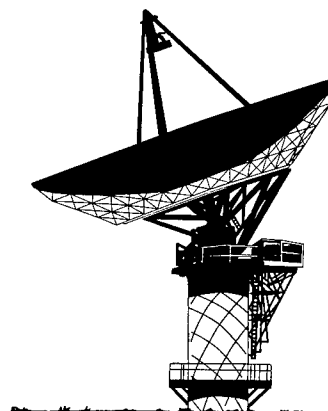
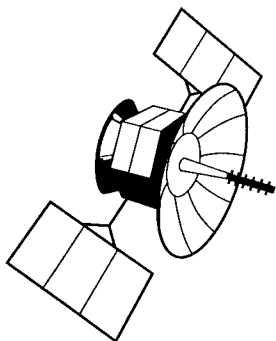


SUMMER-
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Editor

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Applying Neural Networks to Demand Forecasting

Captain Mark A. Abramson, USAF
Captain Harry A. Berry, USAF

Introduction

Numerous studies have shown demand patterns for Air Force reparable items are often highly erratic and difficult to forecast. In recent years, artificial intelligence systems, designed to "learn" from past errors, have made great strides in developing improved forecasting methods. One such system, an artificial neural network, is a computer algorithm, which mathematically learns very complex relationships from historical data between input factors and output variables. When the initial learning process is complete, it forecasts by applying the established relationship for the next period. It also measures its own error and periodically corrects itself. Neural networks appear to be well suited for demand forecasting in the Air Force reparable environment, however this has never been tested. In this paper, we present the results of a study comparing forecasting performance of a neural network to several other forecasting methods as applied to the problem of predicting quarterly demands at the depot. (1)

Background

Artificial Neural Networks

The artificial neural network is a biologically inspired computational structure composed of many highly-interconnected processing elements. The elements, called nodes, process information in parallel and exchange information much like the billions of neurons in the human brain. A neuron fires a signal to all interconnecting neurons when electrochemical charges present in the firing neuron exceed some inherent threshold. The strength of the connections between neurons is believed to be the basis of human thinking abilities. (3) As an example, Figure 1 shows a three-layer network, where data is processed at each node and passed on (to the right) to all interconnecting nodes. Each input node represents an input variable considered by the neural network in its forecasting process. Each hidden layer node computes a linear combination of weighted inputs and passes the resulting value through a nonlinear, threshold-like function. The output node, which represents the actual forecast, performs the same process, but often applies a linear, rather than nonlinear, function. Each hidden and output node has a threshold value assigned, and, when the sum of the values of all the incoming weighted signals exceed the node threshold value, the node is activated and sends a signal to all other succeeding connected nodes. This process is unlike traditional computer programs which perform sequential instructions; neural networks are able to simultaneously explore many competing hypotheses. (9:8)

To set up the neural network to forecast accurately, weights assigned to each variable or node are adjusted between connections to minimize performance error over a set of example

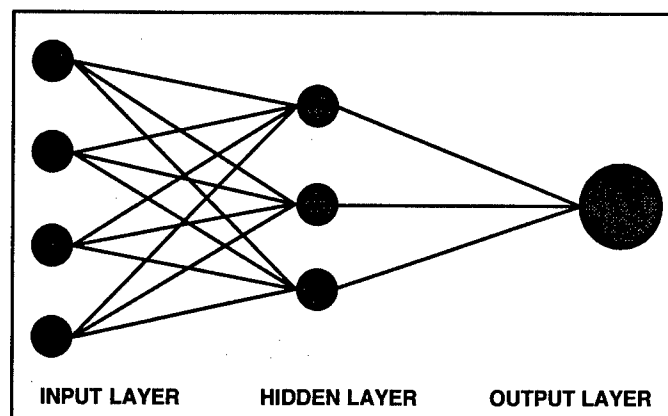


Figure 1. An Artificial Neural Network

inputs and outputs. Once this process, known as "training," is complete, the neural network can make predictions about the behavior of the output variable based on any set of input data. The neural network also modifies its weights as future forecasts are compared with their predictions and feeds them back into the neural network.

The benefits of neural networks are numerous. (7) Perhaps their greatest advantage over other methods is their ability to handle noisy or obscured patterns, including some bad data. (3) Several studies show neural networks using backpropagation have produced more accurate forecasts than regression and Box-Jenkins methods. (8) They have also been successfully used in other forecasting applications, such as predicting upcoming football plays, analyzing bank loan risk, predicting credit card fraud, forecasting pension fund investment growth, and horse race betting. (2,5,6) Reynolds, Faulkner, and Smith show favorable results when neural networks are applied to the inventory range problem for Air Force consumable items. (9) However, due to the complexities of neural network systems, implementation may require special software and more time, effort, and manpower to collect the required data and train and monitor the neural network.

Standard Forecasting Methods

Forecasting methods have long been a topic of study and research. For our analysis, we compared the performance of a neural network to the moving average, naive method, and single exponential smoothing. A description of each is now provided, where the subscript variable t represents the current time period, while $t+1$ and $t-1$ denote the next and most recent time periods, respectively, and the variables F and A denote a forecast and an actual value, respectively.

Moving Average. This method uses the average of the most recent N periods of data as its forecast for the next period. The term "moving average" is used because, as each new period's

observation becomes available, the oldest observation is removed and the average recalculated. Mathematically, this is expressed as

$$F_{t+1} = \frac{1}{N} \sum_{j=t-(N-1)}^t A_j$$

Equation 1

It is simple, easy to implement, and requires N periods of data to maintain. However, because it gives equal weight to each of the last N periods, it reacts slowly to change in the data, except when N is quite small. $N = 1$ produces the *naïve method*, where the forecast is simply the last period's observed value. Choosing N too small, however, could eliminate potentially useful past data.

Single Exponential Smoothing (SES). This method uses a weight parameter α which may be varied between 0 and 1 to place more importance on the most recent actual value versus the most recent forecasted value. It can be described mathematically by any of the following three equivalent (for $\alpha \neq 0$) equations:

$$\begin{aligned} F_{t+1} &= F_t + \alpha(A_t - F_t), \\ F_{t+1} &= \alpha A_t + (1 - \alpha)F_t, \\ F_{t+1} &= \alpha A_t + \alpha(1 - \alpha)A_{t-1} + \alpha(1 - \alpha)^2 A_{t-2} + \dots \end{aligned}$$

Equation 2

Small values of α make the forecasts slow to react to change, while large values produce quick responsiveness but increased variability. (4:684-685) In the extreme cases, a value of 0 yields an unchanging forecast, while a value of 1 yields the naïve method. The weight parameter allows great flexibility and adaptability but usually requires effort to analyze and adjust it.

Methodology

To conduct the study, we used ten quarters of data for 14 F-16 landing gear stock numbers collected by Dynamics Research Corporation (DRC) for the Deputy Chief Of Staff, Logistics (HQ USAF/LG) sponsored "Visions" project. We applied four forecasting methods, namely, the naïve method, eight-period moving average, SES, and a neural network with backpropagation to predict, for each stock number, the number of reparable carcasses to arrive at depot in a future quarter (depot demands). To start with, we used the first eight quarters to establish the parameters of each method and the last two quarters to compare forecast performance. That is, the first eight quarters were used to establish an eight-period moving average (the currently used method), optimize the SES weight parameter, and train the neural network. The neural network, constructed and trained using *Neuralyst* version 1.4 (Cheshire Engineering Corporation), is composed of three layers of sigmoidal units having one output node, three hidden-layer nodes, and one input node corresponding to each input variable. We initially began with 34 input variables, but discarded 11 of them as irrelevant in impacting the number of depot demands.

The remaining 23 input variables, described in Tables 1 and 2, came from two sources, the Recoverable Consumption Item Requirements System (commonly known as D041) and the Tactical Interim Core Automated Maintenance System (CAMS) and the Reliability and Maintainability Information System (REMIS) Reporting System (TICARRS).

To measure forecasting accuracy, we applied the two most commonly used measures—the mean absolute deviation (MAD) and the mean squared error (MSE). The MAD is obtained by taking the absolute value of each of the n prediction errors (actual minus forecast) e_k , $k = 1, \dots, n$, and then computing the mean of the absolute values, while the MSE is obtained by squaring the prediction errors and then computing the mean of the squared values. These measures are expressed mathematically by the equations,

$$\text{MAD} = \frac{1}{n} \sum_{k=1}^n |e_k|,$$

Equation 3

$$\text{MSE} = \frac{1}{n} \sum_{k=1}^n e_k^2.$$

Equation 4

The MAD actually weighs each error equally and measures the absolute size of the forecast error across items, while the MSE penalizes a forecast more for large errors than it does for small ones. For example, an error of 1 would result in an e_k^2 of 1, but an error of 2 would result in an e_k^2 of 4. Thus, the MSE weighs an error of 2, four times heavier than an error of 1.

Analysis and Results

One Period Ahead Forecasts

For the one period ahead forecast we assumed the last period's data was available to make next period's forecast, a condition which today's systems are unable to respond to; however, it provides a good starting point for comparing the methods. Table 3 shows the neural network was 2.4 carcasses (6.19 - 3.79) more accurate than SES, 3.3 carcasses more accurate than the naïve forecast, and almost 5 carcasses more accurate than the eight-period moving average. As shown in Table 4, for individual stock numbers, performance of the neural network and SES were fairly close except for two forecasts, namely, N7181 period 9 (period 10 data was unavailable) and N3141 period 10. In these cases, SES yielded forecast errors of 27 and 50 carcasses, respectively, while the neural network forecasts were off by 4.45 and 0.8 carcasses, respectively.

Forecasts with Aged Data

Forecasting with six-month old data was much more realistic in terms of data availability, particularly when data managers "scrub" D041 data, as is the case for our data. Because of the time lag and the small size of the original sample of demand data, we only provided one forecast per stock number for a total of

Variable	Definition
Could Not Duplicate	Number of base asset failures that could not be duplicated
Base Repairable Generations	Number of base assets which generated a repair
Base Repairable This Station	Number of assets fixed at bases
Depot On-Hand Repairs	Number of repairable assets made serviceable
Depot Serviceables	Number of serviceable assets at the depot
Depot Unserviceables	Number of unserviceable assets at the depot
TOIMDR	Total organizational and intermediate maintenance demand rate

Table 1. Recoverable Consumption Item Requirements System (DO41) Variables

Variable	Definition
Bench Check Serviceables (BCS)	Number of bench check serviceables at bases
Cannibalizations	Number of base assets cannibalized from other weapon systems
Possessed Aircraft Hours	Average number of hours the base possessed the aircraft
Fully Mission Capable (FMC) Hours	Total hours base aircraft were fully mission capable
Not Fully Mission Capable (NPMC) Hours	Total hours base aircraft were not fully mission capable
Not Fully Mission Capable—Supply Hours	Total hours base aircraft were not fully mission capable due to supply
Not Fully Mission Capable—Maintenance Hours	Total hours base aircraft were not fully mission capable due to maintenance
Not Fully Mission Capable—Both Hours	Total hours base aircraft were not fully mission capable due to supply and maintenance
Partially Mission Capable (PMC) Hours	Total hours base aircraft were partially mission capable
Partially Mission Capable—Supply Hours	Total hours base aircraft were partially mission capable due to supply
Partially Mission Capable—Maintenance Hours	Total hours base aircraft were partially mission capable due to maintenance
Partially Mission Capable—Both Hours	Total hours base aircraft were partially mission capable due to supply and maintenance
Average Possessed Aircraft	Average number of aircraft at the base
Flying Hours	Total number of aircraft flying hours during the period
Operational Hours	Total number of aircraft operational hours during the period
Noncomputed Hours	Total aircraft hours not counted as possessed

Table 2. Tactical Interim Core Automated Maintenance System (CAMS) and Reliability and Maintainability Information System (REMIS) Reporting System (TICARRS) Variables

Forecasting Method	Mean Absolute Deviation (MAD)	Mean Squared Error (MSE)
Eight-Period Moving Average	8.67	251.00
Naive	7.11	152.88
Single Exponential Smoothing	6.19	138.62
Neural Network	3.79	29.06

Table 3. One Period Ahead Comparison of Forecasting Methods

Stock Number	Period	Actual	Moving Average	Naive	Single Exponential Smoothing	Neural Network
N5173	9	20	21.7	31	23.78	20.2
	10	23	19.5	20	21.77	22.6
N0478	9	8	11.5	18	13.8	22.09
	10	19	12.5	8	11.65	21.7
N7181	9	206	173.25	178	178.79	210.45
N3141	9	193	166.7	187	187.84	196.3
	10	243	190.8	193	192.94	243.8
N3255	9	0	0.25	0	0.01	0.05
	10	2	0.25	0	0.01	0.52
N7561	9	7	9.75	6	6.02	7.08
	10	6	6.87	7	6.99	6.92
N1559	9	6	8.5	7	9.28	10.29
	10	14	9.25	6	8	11.11
N0430	9	12	11.375	8	10.75	20.52
	10	19	12.875	12	11.12	21.23
N8399	9	27	18.6	16	19.07	13.19
	10	24	22	27	22.08	15.55
N0536	9	0	1.125	2	1.11	0.8
	10	3	1.125	0	0.8	0.58
N9656	9	20	13.75	27	27.01	26.7
	10	18	16.25	20	20.07	26.4
N9655	9	4	5.87	3	5.86	9.03
	10	12	6.37	4	4.93	10.54
N2910	9	10	53.5	7	6.95	10.65
	10	11	6	10	9.96	9.61
N4508	9	18	15.125	19	16.89	22.7
	10	25	17.375	18	17.33	23

Table 4. One Period Ahead Forecasts

Forecasting Method	Mean Absolute Deviation (MAD)	Mean Squared Error (MSE)
Eight-Period Moving Average	47.23	7143.89
Naive	31.71	3370.28
Single Exponential Smoothing	23.69	1825.62
Neural Network	5.12	43.45

Table 5. Six-Month Ahead Comparison of Forecasting Methods

fourteen forecasts per method. The results in Table 5 (above) show the neural network once again outperformed the other forecasting methods. Forecasts for individual stock numbers are provided in Table 6 (next page).

Unscrubbed data may provide the standard tools with current data for making forecasts. Since unscrubbed data was unavailable, we next assumed the data does not change during the scrubbing process—an optimistic assumption. This allowed the standard methods to operate under perfect conditions, while the neural network, because its data sources (DO41 and TICARRS) worked with six-month old data. The results, found in Table 7 (next page), show the neural network still performed best.

Neural Network Sensitivity to Input Variables

One concern with using neural networks is the work load required to collect data for all the input variables needed to ensure accurate forecasts. Reducing the number of input variables reduces work load but also hinders forecasting accuracy. Since data for the 23 variables used came from two data sources, 7 from DO41 and 16 from TICARRS, it seemed prudent to test the accuracy of single source forecasts. To do this, two additional neural networks were constructed: one using DO41 variables and

one using TICARRS variables. The results shown in Table 8 show the 16 TICARRS variables were more crucial to making an accurate forecast than D041 data, but the most accurate forecast came from using both data sources. In fact, SES and the naive forecasts showed slightly smaller MADs than the neural network forecasts with partial data.

We also attempted to selectively reduce the number of input variables by examining and interpreting the values of the weights assigned by the neural network. However, variable sizes made the weights meaningless. For example, base reparable generations and reparable this station (RTS) numbers generally have one to two digits, while mission capable hours and aircraft possessed hours are six-digit numbers. One way to circumvent this problem is to use for input the natural logarithm of each input variable, and then apply the inverse logarithm to the output to come up with an appropriate forecast. This process, commonly known as variable scaling, eliminates the very large differences

Stock Number	Actual	Moving Average	Naive	Single Exponential Smoothing	Neural Network
N5173	23	18.62	1	1.07	24.39
N0478	19	4.87	0	5.4	3.53
N7181	206	57.25	17	81.67	193.19
N3141	243	57.25	151	150.9	249.66
N3255	2	0	0	0	0.05
N7561	6	21.5	0	1.97	8.22
N1559	14	3.5	1	5.53	10.28
N0430	19	4.87	0	5.54	11.45
N8399	24	7	1	8.9	25.64
N0536	3	0.62	1	1	0
N9656	18	3.5	1	4.9	20.32
N9655	12	2.75	8	8	6.72
N2910	11	215.1	0	9.9	8.57
N4508	25	6.12	0	8.47	19.68

Table 6. Six-Month Ahead Forecasts

Forecasting Method	Mean Absolute Deviation (MAD)	Mean Squared Error (MSE)
Eight-Period Moving Average	8.67	251.00
Naive	7.11	152.88
Single Exponential Smoothing	6.19	138.62
Neural Network (With Aged Data)	5.12	43.45

Table 7. One Period Ahead Comparison of Forecasting Methods With Neural Network Using Aged Data

Forecasting Method	Mean Absolute Deviation (MAD)	Mean Squared Error (MSE)
Neural Network: TICARRS and DO41	3.79	29.06
Neural Network: TICARRS Only	7.12	105.68
Neural Network: DO41 Only	22.96	4,283.64
Single Exponential Smoothing	6.19	138.62
Naive	7.11	152.88

Table 8. Neural Network Performance Using Various Data Sources

in variable size and makes weight values more meaningful indicators of importance of each variable to the forecast. However, this is not mathematically equivalent to using the original variables; when we performed this transformation, the forecasts were not as accurate. Thus, getting more meaningful weights for interpretation can sacrifice forecast accuracy.

Stepwise regression, another forecast technique which uses other input variables, can also be used to identify which variables have the strongest correlation to the actual number of carcasses arriving at depot. Unfortunately, none of the 23 variables were statistically important for all fourteen stock numbers. In fact, several cases showed no statistical significance for any of the variables.

Conclusions

For the set of reparable items we considered, neural networks outperformed the other forecasting methods. In fact several methods outperformed the currently used eight-period moving average. Although the sample of data was small, we concluded neural networks show great promise as a tool to improve demand forecasting and recommend the Air Force pursue further study in this area with a much larger set of data. Neural networks may be particularly valuable when dealing with systems that cannot produce timely data with which to forecast. They are also adept at dealing with inaccurate and noisy data, a condition common in many Air Force data systems. However, in future research, there are some issues that must be considered.

First, the construction and training of a neural network involves as much art as science. For this project, we used a three-layered network because it was recommended by several textbooks. In this case, it proved to be a good forecasting structure, but it would need to be validated for a larger sample of many stock numbers across many weapon systems. There are also numerous parameters that can be adjusted within the neural network structure that can improve forecasting accuracy. The forecaster must make these adjustments based on experience and understanding of the data.

Second, under the new wholesale philosophies (the Depot Senior Leaders Materiel Course), the concept of "repair on demand" reduces the importance of being able to forecast the next period's depot demands. Perhaps a more appropriate use would be as a repair and buy forecasting tool for predicting quarterly failures of reparable items. Currently, D041 uses an eight-period moving average of past failures as an input into determining requirements and allocating base and depot levels. If the neural network forecasts next quarter's failures as accurately as depot carcasses in this project, it could provide better repair budgets and stock level allocations. As a long-term tool, a neural network forecast of failures can be used in determining buy requirements for Air Force Materiel Command.

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(Continued on middle of page 9)

PRO-ACT Solvent Substitutions—Here's How We Do It

Thomas K. Cain
James E. Lanou

Introduction

You just took an inventory of your cleaning supply locker and realize you are down to your last can of ZipZap Eats-Away Miracle No-Scrub cleaning compound. No sweat! Fill out a requisition form and send it over to supply. **Oh no!** The Hazardous Materials (HAZMAT) Pharmacy says you can not use ZipZap anymore unless you have proper justification. **It contains a solvent that is identified as an EPA-17 priority pollutant chemical!** As you stare in frustration at your last can of ZipZap Eats-Away you think—so now what do I do?

PRO-ACT, the Air Force Center for Environmental Excellence environmental information clearinghouse, has received many inquiries regarding the status of substitution efforts to replace products that contain ozone depleting substances (ODSs), Environmental Protection Agency-17 (EPA-17) high priority pollutants, or health hazard ingredients. Clearinghouse researchers have conducted extensive research into finding substitutes or potential substitutes for solvents used by Air Force activities. This article presents an overview of how PRO-ACT conducts the research and a brief overview of the information resources available to assist in identifying potential alternatives.

The PRO-ACT Process

The PRO-ACT process uses the following steps:

(1) *Define the question.* Research for solvent (and other product) substitutions begins with the interview with the customer. It is vital to get all the information in order to provide a satisfactory response. The researcher will determine answers to the following questions: On what type of equipment is the solvent used? How critical is the application? Are there technical orders or military specifications mandating use of a specific product or formulation? What chemical are you trying to eliminate, and why? The more information gained from the customer, the faster a response can be provided.

(2) *Search existing records.* PRO-ACT has responded to over 13,000 technical inquiries since its start-up in October 1992. The database contains the responses made to each inquiry and provides leads to the solution, and in many cases, the actual answer. Searching the database with key words, national stock numbers, specification numbers, or weapon system mission design series may lead PRO-ACT researchers directly to the answer.

(3) *Identify constraints.* If a technical order or military specification is involved, the next step is to review it to see if it requires a specific formulation or has a qualified products list. This provides background information when contacting

individuals or engineering activities with management responsibility for the process requiring use of the solvent or product. This may also narrow the list of potential alternatives.

(4) *Consult the experts.* Item manager is a term commonly used to refer to an equipment specialist, engineer, or inventory manager at an Air Logistics Center or within a weapon system single manager function. This term has also been used when referring to a military or federal specification manager. Any of these individuals may have information on substitutes approved for use (or those being evaluated for use) in a specific application. PRO-ACT routinely finds a substitute has been evaluated and approved, but the technical order or specification changes have not yet made it to the field. However, we sometimes also discover there are no approved substitutes for a specific application. In this case, we alert the appropriate management function that a need exists to eliminate the use of a product or solvent. We then try to assist the responsible management function by identifying potential substitutes or alternative processes for their evaluation.

(5) *Contact product manufacturers.* Commercial industry has been working to eliminate use of hazardous solvents longer than we have. In many cases a product containing a hazardous or undesirable solvent has either been reformulated or replaced. The product manufacturers readily inform PRO-ACT if a newer product is available. They can usually tell us if a new product has been stock-listed.

(6) *Look for other crossfeed information.* Other agencies and services collect, post, or otherwise compile solvent substitution information. PRO-ACT routinely contacts other resources to try and identify substitution initiatives. Some of these include:

- Defense Logistics Agency.
 - Defense Supply Center Richmond (formerly Defense General Supply Center).
 - Hazardous Technical Information Services.
- General Services Administration (GSA).
 - GSA Paints and Chemicals Commodity Center.
- Environmental Protection Agency.
 - Significant New Alternative Policy Program.
 - Clearinghouses and hotlines.
- Solvent substitution bulletin boards/web sites.

Description of Selected Resources

The following is a brief overview of selected government agencies' efforts to identify and replace solvents or products containing hazardous solvents:

Air Force Materiel Command (AFMC) established several integrated process teams to provide assistance in eliminating the use of hazardous solvents. The teams are working with Air

Logistics Centers (ALCs) and other AFMC centers to identify references to ODSs, EPA-17, and ultimately all toxic release inventory reportable hazardous chemicals in all Air Force technical orders, specifications, and standards. Several thousand documents were digitally scanned to search for hazardous chemicals. This identification process will allow weapon system single managers to locate and replace references to hazardous chemicals with alternatives when possible.

Within AFMC, ALCs are responsible for the management of Air Force equipment and their associated technical orders. ALC product engineering teams (consisting of "item managers" mentioned earlier) are working to determine product performance needs and identify more environmentally friendly products. As these products are identified, tested, and qualified to the appropriate Air Force standards, they are assigned a national stock number and incorporated into the applicable technical orders.

On 1 October 1996, PRO-ACT gained the mission of the Ozone Depleting Chemical (ODC) Information Exchange in order to provide a single "one-stop" source for information on alternatives to hazardous materials for weapon systems support. The ODC Information Exchange, originally a portion of the Human Systems Center Pollution Prevention Directorate (HSC/EMP), worked on the identification of ODC-free products qualified to the applicable specifications for Air Force weapon systems.

HSC/EMP also developed and recently made available the HAZMAT Information Exchange On-Line Tool (EIT). EIT is an electronic centralized library system for the collection, storage, and retrieval of hazardous materials information. EIT, in conjunction with the PRO-ACT data, will allow engineers, equipment specialists, program manager, and others involved in researching alternatives to hazardous solvents to use a central database to get the latest news on what materials are available, approved, or pending approval for use as specified in Air Force technical data or specifications.

The Defense Logistics Agency has hundreds of environmentally preferred products listed in their December 1995 Environmental Product Guide to assist organizations in reducing hazardous waste, eliminating the use of ODCs, and protecting employees. This is a great resource for information on stock-listed products for cleaning processes which are not controlled by a technical order.

General Services Administration (GSA) has catalogued approximately 2900 environmentally beneficial products in their Spring 1996 Supply Catalog and February 1995 Commercial Cleaning Supplies Catalog to assist organizations in waste reduction and elimination of hazardous solvents. The GSA Paints and Chemicals Commodity Center chemical engineering staff has conducted extensive research in reducing or eliminating solvent usage associated with aerospace and facility coatings applications.

The Defense Environmental Network Information Exchange (DENIX) bulletin board system contains information on product substitutions. Files containing information on suitable or potential alternatives can be viewed or downloaded from the "subject areas" menu. Under the pollution prevention section of the subject areas menu, Air Force PRO-ACT responses may be

viewed by category. Also, the Department of Defense Pollution Prevention (P2) Technical Library can be accessed, which contains information on solvent alternatives consolidated by the Naval Facilities Engineering Service Center (NFESC). DENIX also provides gateways to several other bulletin boards or world wide web sites containing solvent alternative information including Enviro\$en\$e.

Enviro\$en\$e, funded by both the Environmental Protection Agency (EPA) and the Strategic Environmental Research and Development Program, allows access to information on processes and techniques in pollution prevention. Enviro\$en\$e allows those implementing pollution prevention programs to benefit from the experience, progress, and knowledge of their peers (lessons learned). It includes a pollution prevention forum for all levels of government, researchers, industry, and public interest groups. Enviro\$en\$e was developed to host an expert architecture known as the Solvent Umbrella. The Solvent Umbrella allows users to access solvent alternative information from multiple sources through a single structure.

Through DENIX and Enviro\$en\$e, links are available to the Solvent Umbrella which contains the following information sources:

- News, Resources, Contacts, and Funding.
- Federal, Regional, State, and Local Programs.
- Technical/Research and Development Information.
- Solvent Substitution Data Systems. Connecting to this link allows access to the following systems:
 - Integrated Solvent Substitution Data System.
 - Solvent Alternatives Guide.
 - Hazardous Solvent Substitution Data System.
 - DoD Ozone Depleting Chemical and Substance Information.
 - Solvent Handbook Database System.
 - National Center for Manufacturing Sciences.
- Enviro\$en\$e and Solvent Umbrella Project Participants.
- Links to Related Systems.

Conclusion

There are many sources for information on acceptable (or potentially acceptable) substitutes for hazardous solvents. We have provided some insight into our process, some information sources used, and the status of a few government agency substitution research efforts. The substitute may be in the form of an alternate product or a change in a process. The individuals who are required to use the substances, in many cases, do not have the time, resources, or experience to search for alternatives. PRO-ACT has gained that experience and knows where to go to find information on approved substitutes, changes in processes, or the status of research efforts for alternatives. Air Force activities are invited and encouraged to use PRO-ACT as a source for the latest information on solvent substitutes. PRO-ACT can be reached by any of the following means:

Phone: DSN 240-4214
Toll Free (800) 233-4356
Commercial (210) 536-4214

(Continued on middle of page 9)

Environmental News

Top Five Hazardous Materials Identified at ACC Bases

This is the second part of a two-part article discussing an initiative to identify the top five most-used hazardous materials in ACC [Air Combat Command] logistics industrial processes. Part one was published in the March 1996 issue of *Global Environmental Outreach* (Volume 3, Issue 4).

The purpose of this study was to determine the five hazardous materials (HMs) most used to support ACC weapons systems, and, once the top five were identified, to determine the affected weapon systems and technical orders (T.O.s) that required the use of the HMs. For the context of this study, the weight of the constituent chemicals in the various HMs used to support ACC weapon systems was the single factor in determining the most-used HMs. Fuels were exempt from the study.

Based on the final results of the study, the five most-used HMs in ACC were found in 54 NSNs [national stock numbers]. These HMs and their usage in FY95 [fiscal year 1995] were as follows: ethylene glycol, 390,093 pounds; methyl ethyl ketone (MEK), 72,696 pounds; bis (2-ethyl hexyl) adipate, 22,777 pounds; toluene, 18,184 pounds; and sulfuric acid, 13,909 pounds. Some of these chemicals, such as ethylene glycol, MEK, and sulfuric acid, were used both at 100 percent concentrations and only as constituents in other commodities. In general, the HMs were found in products such as antifreeze, deicing fluid, oil, hydraulic fluid, paint, thinner, polyurethane, sealing compounds, and batteries.

The HMs were used to support 181 weapon systems and approximately 490 T.O.s mandated the use. Further research revealed 29 System Program Offices (SPOs) and Air Logistics Centers were responsible for the T.O.s that called for the use of these HMs. Complete replacement of the top five most-used HMs would reduce Command-wide hazardous material usage by 517,660 pounds per year. Elimination of MEK and toluene would reduce EPA-17 toxic chemical usage by 23.5 percent based on the Command's 1992 baseline. Actual reductions will be less because many of the materials will probably be reformulated to reduce their concentrations of HM, rather than be replaced altogether.

Of the five HMs identified, the three with the best potential for reduction are ethylene glycol, MEK, and toluene. Ethylene glycol could be significantly reduced by using a more environmentally acceptable aircraft deicing fluid, modifying operational procedures, or developing non-chemical deicing processes. Each of these initiatives is being actively pursued by a new Air Force-level deicing fluid working group.

The reduction of MEK and toluene is also very promising with the development of many new paints with low concentrations of hazardous air pollutants (HAPs) and volatile organic compounds (VOCs). Two military specifications (MIL-C-85285 and TT-P-2756) have already been developed for low-HAP and low-VOC top coats. Low-HAP and low-VOC primers widely used for aircraft application are covered by MIL-P-23377 and TT-P-2760.

The Air Force Corrosion Office has already included these military specifications in T.O. 1-1-8. For some specifications, it is important to note the type and class of the coating material to ensure that low-HAP and low-VOC versions are procured and used.

A final report was provided to appropriate SPOs and HQ Air Force Materiel Command (AFMC) to enable these activities to find substitute materials and/or to develop alternative processes to reduce or eliminate the HMs. (Point of Contact: Charlie Nault, Parsons Engineering Science, Support Contractor for ACC/LGOV, DSN 574-9454 or (757) 764-9454.)

ACC Continues to Explore Deicing Options

Icy aircraft and runways can jeopardize the life of a pilot and the mission of an air base. To protect pilots, aircraft, and mission objectives, the Air Force must remove or discourage dangerous snow, ice, and slush accumulation. This task is commonly known as deicing.

Aircraft deicing is usually performed on the parking ramp before the aircraft is prepared and serviced for flight. It is performed whenever an aircraft will encounter icing conditions during the critical take-off and climb-out portion of its flight. This procedure is performed as close as possible to departure time.

The Problem

Although research is underway to identify less harmful methods, the Air Force is currently forced to rely on the use of chemical deicing agents that can adversely affect the surrounding environment. A substantial percentage (up to 80 percent) of ethylene glycol- or propylene glycol-based aircraft deicing and water solutions falls off the aircraft or runs off the runway and enters the stormwater drainage system. The requirements to obtain or renew stormwater discharge (NPDES) [National Pollution Discharge Elimination System] permits are becoming more stringent every year. Modifying our present deicing practices will make the Air Force more responsive to these changing federal water pollution control requirements.

The Approach

In response, HQ ACC/CEVCM recently launched a deicing/anti-icing operations compliance evaluation and requirements identification study for all ACC bases. Detailed questionnaires will be sent to 18 ACC bases, 11 bases will be visited, and MILCON [military construction] packages will be developed for 5 bases. Additionally, samples will be taken from deicing operations this winter. Representatives from HQ ACC/DO and LG have been invited to be OCRs [offices of collateral responsibility] for this study, while Armstrong Laboratory (AL/OEBW) will provide technical project management support.

The primary purpose of the project is to evaluate operations related to aircraft and airfield (runway) deicing/anti-icing at ACC bases to determine requirements for maintaining compliance into the 21st century. This task will be accomplished through an

information-gathering effort to: (1) identify current compliance issues, and operation and management practices, for each installation covered in the study; and (2) review literature/technology for treatment technologies in use, infrastructure improvements, management and operation practices, or other potential means of treating, handling, disposing, or otherwise dealing with the waste generated by deicing/anti-icing procedures. It is anticipated that the literature/technology review will identify three non-ACC bases and three civilian facilities that have exemplary deicing/anti-icing programs that can be evaluated in detail.

The Solution

After the information-gathering effort is completed, the following activities will be conducted: operations/management and facility/infrastructure improvements needed for compliance will be determined; an assessment of the need for, or applicability of, treatment technologies will be made; an evaluation of opportunities for reduction, reuse, and recycling or other pollution prevention potential will be completed; and base sampling and compliance requirements will be discussed. Finally a Customer Concept Document will be developed to be used in the programming for design and construction of the applicable MILCON solutions for each base.

"No one has taken a big picture look to see if deicing operations are in compliance with the NPDES program. We want to identify short-term and long-term fixes to bring ACC bases into compliance," noted Capt Franz Schmidt, AL/OEBW. "This is the first compliance-type study where we are bringing in Operations and Logistics people in addition to the Environmental and Bioenvironmental Engineers."

The 18 ACC bases included in the study are Barksdale AFB, Beal AFB, Cannon AFB, Davis-Monthan AFB, Dyess AFB, Ellsworth AFB, Holloman AFB, Langley AFB, Little Rock AFB, Minot AFB, Moody AFB, Mountain Home AFB, Nellis AFB, Offutt AFB, Pope AFB, Seymour Johnson AFB, Shaw AFB, and Whiteman AFB. (Point of Contact: Gary Nault, HQ ACC/CEVCM, Langley AFB, DSN 574-3668 or (757) 764-3668.)

Source: "Exploring Available De-Icing Technologies." *Cross Talk*. Edition 24 May 1996. Published by PRO-ACT.

Don't Burn Those Leaves!

As more and more states ban the disposal of yard trimmings in landfills, the likelihood that residents may begin burning leaves and other yard waste increases. While leaf burning is considered by some to be a fall ritual, it can lead to air pollution and health problems. *Further, open burning of leaves is illegal in many communities and can incur large fines!*

The Pollutants

Three primary pollutants are emitted when leaves are burned: particulate matter, carbon monoxide, and hydrocarbons. On average, 1 ton of burning leaves will emit 38 pounds of particulate matter, 112 pounds of carbon monoxide, and 26 pounds of hydrocarbons. Wetter leaves can actually increase emissions of all these pollutants. Carbon dioxide, which is believed to significantly contribute to global warming, is emitted as well.

Particulate Matter

The smoke from leaf burning is composed of tiny particles known as particulate matter. If inhaled, these microscopic particles can reach the deepest regions of the lung and remain there for months or even years. Breathing particulate matter can increase the chances of respiratory infection, reduce the volume of air inhaled, and impair the lungs' ability to use that air. Particulate matter can also trigger asthma attacks in some people.

Carbon Monoxide

Carbon Monoxide is an invisible gas that is emitted when leaves are burned. When inhaled, carbon monoxide is absorbed into the bloodstream through the lungs, where it combines with red blood cells and inhibits oxygen from being carried in the red blood cells at normal levels. When this occurs, body tissues are starved of needed oxygen, and heart and respiratory tract diseases can result.

Hydrocarbons

Found naturally in leaves, hydrocarbons are organic chemical compounds that exist as gases or are absorbed onto soil particles. As leaves die and the chlorophyll-containing parts of the leaves turn yellow, hydrocarbon levels increase by 3 to 5 times. If the leaves are burned, the hydrocarbons are released into the atmosphere. Some of these hydrocarbons, such as aldehydes and ketones, cause irritation to the eyes, nose, throat, and lungs. Also, a substantial portion of the hydrocarbons in leaf smoke consists of polynuclear aromatic hydrocarbons, some of which are known cancer-causing agents.

The Alternative

A better alternative for disposing of yard waste, including leaves, is composting. Composting is a safe and environmentally sound method of managing yard waste, and applying compost to existing soil actually reduces erosion and helps soil retain moisture and nutrients. Composting is a simple process that involves placing yard trimmings and other organic materials in a pile or bin, maintaining adequate moisture, and turning the pile periodically to mix in air. Naturally occurring microorganisms gradually break down the pile into a humus-like product called compost.

As an additional incentive, Air Force Instruction 32-7080, issued 12 May 1994, mandates that each ACC installation will operate a composting program or participate in a regional composting program, and, at a minimum, the composting program will include yard wastes. (Point of Contact: Tim Blevins, HQ ACC/CEVV, Langley AFB, (757) 764-3252, or DSN 574-3252)

Source: "Leaf and Yard Trimming Management: Composting Versus Residential Burning." Office of Air and Radiation, U.S. Environmental Protection Agency. Publication No. EPA-452/F93-010. April 1993.

More Ways to Manage Your Yard Waste

Managing plant material from around your home and garden is an easy and effective way to help ease the strain on our overtaxed landfills. By some estimates, yard waste—such as grass clippings, fallen leaves, weeds, hedge and tree trimmings,

and even sawdust—fills up to 20 percent of the space in our nation's landfills. Here are some ideas to better manage your yard waste:

1. Keep your lawn at a medium length. Keep your mower blade sharp and your blade height high (e.g., 2 to 3 inches).

2. Leave grass clippings on the lawn. The clippings will provide nutrients for a healthier, more durable lawn, and you'll save money and time.

3. Use woody twigs and other debris as mulch. Place the mulch around flower beds, gardens, trees, and shrubs to control weeds, conserve water, and prevent erosion.

4. Consider backyard composting. Composting speeds up the natural decaying process and produces a rich soil conditioner—called humus—that can be reused in your yard. Consult your city or county agricultural agent or base Environmental Flight for ideas on starting a backyard compost pile.

5. Buy or rent a portable chipper. Reduce the size of tree trimmings and prunings that you send to the landfill to conserve landfill space. Chipped yard waste (or "shredded items") produces better results in compost piles. Chippers are usually available through MWR [Morale, Welfare, and Recreation] equipment rental.

6. Consider reducing the size of your lawn. Cover areas with mulch or ground cover. Better yet, turn part of your yard into a rock garden, which requires no water!

7. Stick to native grasses and plants. Varieties of grasses and plants that are native to an area need only about half as much

water as plants that are non-native or imported. This is referred to as "xeriscape."

8. Recycle holiday trees. Christmas trees are mulched in some communities, and some coastal communities use them for erosion control, or consider buying a live tree and planting it in your yard after the holidays.

A Standard Recipe for Backyard Compost

1. Start with a 6- to 8-inch layer of carbon wastes (or "dry brown stuff"), such as dead leaves, woody brush, plant stalks, and even shredded cardboard.

2. Follow with a 2-inch layer of nitrogen material ("or wet green stuff"), such as grass clippings and plants.

3. Add a 1-inch layer of soil or sod.

4. Repeat above recipe, watering as you go.

The three most important ingredients in any compost pile are moisture, oxygen, and temperature. Water your pile as needed to keep it wet as a squeezed-out sponge, and poke holes in it or stir it periodically to speed the decomposition process. If your pile is warm to the touch, your recipe is right!


Source: "About Managing Yard Waste." Channing L. Bete Co., Inc. South Deerfield, MA. 1991.

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(Continued from page 4)


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Most Significant Article Award

The Editorial Advisory Board has selected "Predicting Wartime Demand for Aircraft Spares" by F. Michael Slay, Craig C. Sherbrooke, PhD, and Lieutenant Colonel David K. Peterson, USAF, as the most significant article in the Spring 1996 issue of the *Air Force Journal of Logistics*.

Digital Data in the Land of Department of Defense Logistics

*Karen S. Wells
William J. Wagner*

The Deputy Under Secretary of Defense for Logistics, DUSD(L), chartered the Joint Logistics Systems Center (JLSC) to showcase new logistics support information systems and a Defense Information Infrastructure by implementing some logistics projects which could apply to all services. Two of the logistics projects, the Automated Engineering Change Proposal (ECP) Review and Approval, and the Automated Technical Order (TO) Review, Approval, and Distribution, are discussed here. The automated ECP and TO projects integrate the Joint Computer-Aided Acquisition and Logistics Support (JCALS), the Joint Engineering Data Management Information Control System (JEDMICS), and the Configuration Management Information System (CMIS). These integrated information systems form the foundation for an Integrated Data Environment (IDE). An IDE is the computer hardware, software, and communication infrastructure which permits a weapon system to store data once and share it across the Department of Defense (DoD) and to access all needed data from a single desktop machine. This data should be acquired by the weapon system manager in a digital format such as tape, CD, disk, direct file transfer, etc.

Introduction

If one area is ripe for digital data, it is logistics. DUSD(L), recognizing the growing need for acquiring and managing information digitally, decided to select a place to showcase the new logistics systems. Warner Robins Air Logistics Center (WR-ALC), Robins AFB, Georgia, was selected in May 1994 as the main demonstration site, owing to its triple functionality as an inventory control point with both maintenance and storage depot, as well as its modern infrastructure. In June 1994, DUSD(L) chartered the Joint Logistics Systems Center to set up an office to handle the projects. The Program Management Plan was approved and the Automated Systems Demonstration (ASD) Program Management Office was ramped up in October 1994. It was placed under the JLSC Chief of Staff with direct reporting to the JLSC Commander. A parallel office, a Demonstration Management Office, was likewise established at WR-ALC to handle customer interface issues such as installation and training. Funding followed in January 1995.

Of about 20 projects submitted, nine projects were approved by DUSD(L) in November 1994. The nine projects consisted of four projects in the depot maintenance area and five in the digital data area, most of which were associated with materiel management. The four depot maintenance projects were: the Computer Based Education/Training for Manufacture Resource Planning-II, Automated Data Load, Automated Interface Strategy (for combining two hazardous material management systems), and the Depot Maintenance Technical Infrastructure. The five digital data projects were: the Automated Item Manager, Global

Access to Tube Bending Data, Digital Engineering Data Distribution, Automated Engineering Change Proposal Review and Approval, and Automated Technical Order Review, Approval, and Distribution.

Why were these projects selected? The key reason was these projects shared a commonality of function across DoD components and represented an excellent opportunity to provide a positive return on investment. This was important because, even though an Air Force site was to be implemented, the projects had to demonstrate applicability beyond Air Force bounds to increase the opportunity to reap savings for all of DoD. The projects were also selected because of their direct and indirect support to both the weapon system manager and the warfighter. The two projects presented for discussion here, the ECP and TO projects, automate key business processes for both the weapon system manager and the warfighter.

Approach

The rules of engagement for the demonstrations were as follows. The projects had to be up and running in about a year. They would be conducted in a "limited production" environment. The business process would be "real," but for a limited set of customers. The projects would be brought "on-line" for an evaluation period of one to two months to collect cost, technical, and customer data for a final report. After the "demo" was concluded, the customer would choose to continue or discontinue the effort. Regardless of the outcome, the customer would keep any equipment which was purchased for the effort. These projects would not interfere with the normal business life of the weapon system. The prime directive was that the customer was in charge of the project. Only as much reengineering as the customer could "stand" would be done and the project would only be "turned on" when the customer was ready for it to commence.

Within the scope of these projects, the focus was narrowed to specific weapon systems based on availability of digital data. In this case, the F-15E airframe became the focus. This does not mean that acquiring data was easy. To the contrary, one of the lessons learned in these projects was sources for current, useful, indented data are few, and data must be highly screened and manipulated before it can be used.

The three logistics systems selected for providing ECP and TO functionality were JCALS, JEDMICS, and CMIS. JCALS contributed the ability to locate data through its Global Data Management System, the ability to package data in its workfolders, and the ability to route data via a workflow management system. JEDMICS was selected because it is the DoD repository for engineering data. CMIS was selected because it is the DoD system for weapon system configuration management and contains the ECP information and indented

parts breakdown lists. CMIS also contains the indexes to the respective TOs and drawings associated with the weapon system part.

The system architecture called for JCALS to be the single desktop interface as well as the single system interface to CMIS and JEDMICS. The JCALS environment would permit users to access CMIS (without a second log-in), find the proper part number, and use the associated drawing index to retrieve associated drawing(s) from JEDMICS without ever knowing they left the JCALS desktop. An interface had to be constructed between JCALS and CMIS, but a JCALS to JEDMICS interface was already in place via the existing JEDMICS Application Program Interface (API).

Even though security is a big issue, it was intentionally not addressed in this project since only unclassified data was used. However, there was an issue in system access. The available JCALS-JEDMICS access was not used in this project because it did not satisfy the JEDMICS system administrator for the ASD projects. The JCALS-JEDMICS access permitted all JCALS users to enter JEDMICS while passing a global JCALS log-in and password. This did not satisfy the requirement to be able to identify the person accessing the JEDMICS database. So, the system was modified to pass the user's JCALS log-in and password to the JEDMICS database. This was recognized as a temporary fix and not the long range solution. The JCALS-CMIS access was processed via JCALS PC Client and used the CMIS.INI file to store a valid CMIS log-in and password to permit launching CMIS without requesting a log-in and password.

Software configuration management proved to be the biggest challenge of the ECP and TO projects. JCALS Build 5.0 Drop 16 was used along with CMIS 5.0 Drop G and JEDMICS version 2.5. It took approximately one year to integrate these systems and the biggest hurdle was the lack of a single configuration management authority over these systems. For example, integration began with CMIS 4.3 and the Air Force functionality was added to form CMIS 5.0. It took about two months to move from CMIS 4.3 to CMIS 5.0, which the F-15 System Program Office (SPO) required. The move to CMIS 5.0 required a new interface with JCALS and additional mapping of new data items from the data sources. A few months later, JEDMICS upgraded its software version from 2.4 to 2.5 and forced a new interface with JCALS that was not released until a month or so later.

Data Sources

The other big challenge was data, or rather, locating good data sources. JEDMICS data was not a problem. The information came from the transition of Air Force's Engineering Data Computer Assisted Retrieval System. For the ASD projects the data to be used was for F-15E airframe, although all F-15 data was available. TOs came courtesy of the Air Force Product Data Systems Modernization (AF PDSM) Office and a WR-ALC initiative to digitize its TO warehouse. The F-15E airframe TOs were given priority and arrangements were made with McDonnell Douglas Aerospace (MDA) to deliver digital TOs in monthly increments for use during the project. MDA delivered the TOs to WR-ALC in portable document format (PDF) and both the AF PDSM Office and WR-ALC indexed the TOs to provide them

in indexed portable document format (IPDF). Seven illustrated parts breakdowns (IPBs) were provided by MDA in Standard Generalized Markup Language (SGML) format. Part of the assessment of the TO project was to determine the proper format for viewing digital TOs in the wing backshops and maintenance areas. TOs were stored in JEDMICS, since JEDMICS was determined to be the repository for technical engineering information for these projects.

Finding F-15E data for CMIS was an exercise in perseverance. CMIS contains the data for indentured weapon system parts breakdown lists as well as ECP information. CMIS also contains the relationship of parts to ECPs, TOs, and drawings, as well as other information. None of this data was available from a single source. The parts breakdown information came from MDA. None of the Air Force legacy systems were determined to have complete, indentured information that matched that of MDA. Fortunately, MDA was already providing a quarterly update tape to WR-ALC from which information was extracted for F-15 SPO use. This same tape was used to populate CMIS. Unfortunately, this was only for baseline information; none of the current configuration information was available. Historical ECP data came from the F-15 SPO's legacy system called the System Program Office Management Information System. Some of the relationships of TOs to parts came from the actual TOs themselves. The bulk of the TO to part number data came from the MDA tape. Fortunately for the F-15 system, the numbering system for drawings closely matched the numbering system for parts. This gave a starting point for relating the data, but it was still a tedious process. Problems arose in the information gaps in the parts breakdown list and in the sheer volume of data required to be related to bring CMIS up to speed. The main lesson learned here was that CMIS is a "data hog" and requires a vast amount of data investigation and scrubbing to make it worthwhile. Unfortunately, in this project, the Air Force legacy feeds to keep CMIS current were not available. However, quarterly updates already available from MDA aided in keeping the baseline data current.

The goal for JCALS was to provide locator and index information to tell from which CMIS or JEDMICS database to pull information. This project only provided access to one JEDMICS and one CMIS database, so the full potential of JCALS was not exercised. Therefore, there are some questions to be answered in future efforts. One question is how to organize the CMIS and JEDMICS databases across DoD. Another question is how information should be loaded and indexed across the three systems.

Infrastructure

The equipment used in the ECP and TO projects provided an Integrated Data Environment (IDE) and demonstrated how it could be used to support the weapon system manager and the warfighter. Figure 1 (next page) shows the infrastructure for the IDE. The main database machine was a Sun SPARC 2000 located at WR-ALC which contained the CMIS and JCALS databases. The JEDMICS database was housed on optical platters in a Silicon Graphics machine. Three Hewlett Packard (HP) application servers were distributed among MDA, the F-15 SPO at WR-ALC, and the F-15 SPO at Wright-Patterson AFB

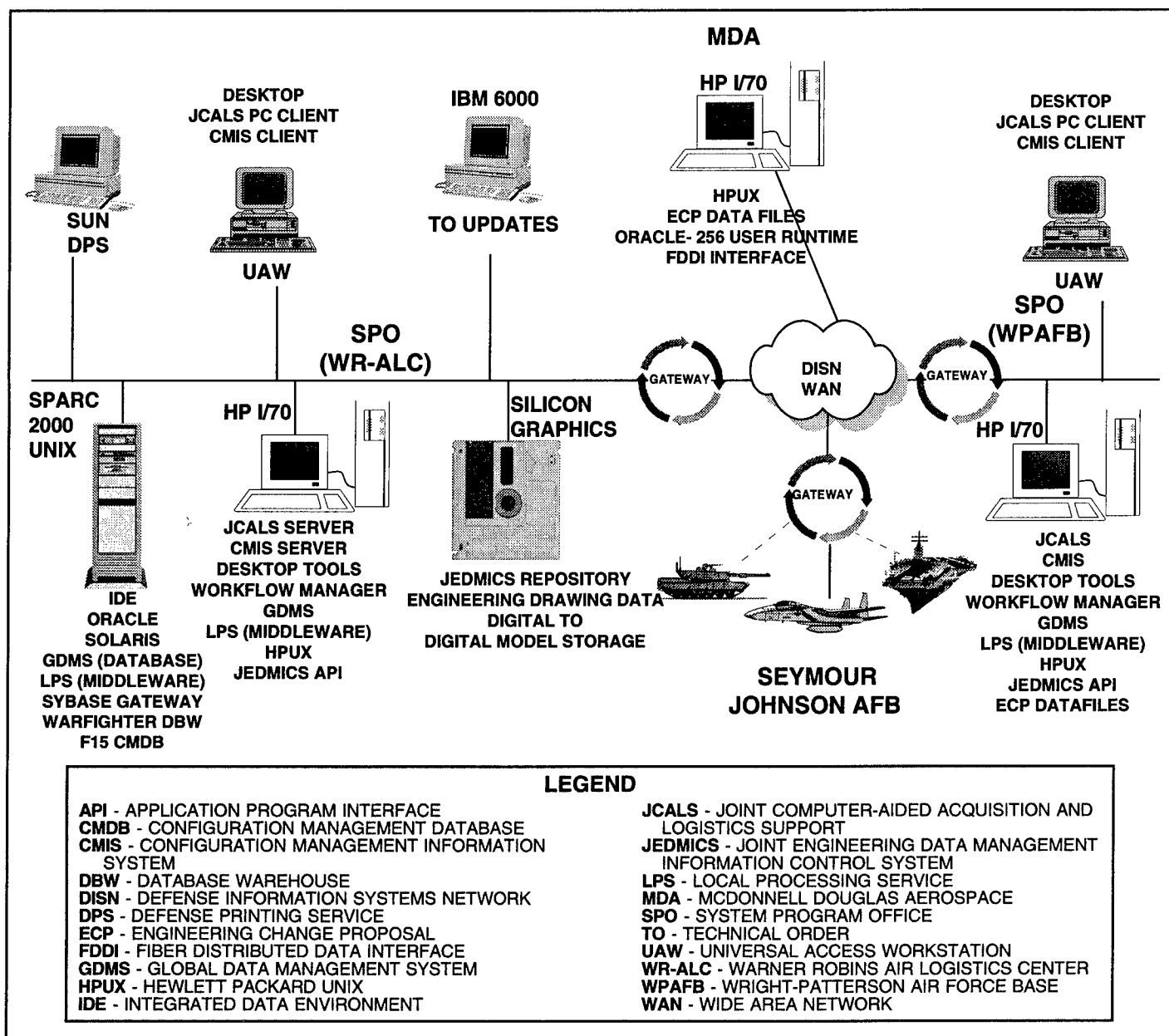


Figure 1. Integrated Data Environment

(WPAFB), Ohio. The two HP I/70s at the F-15 SPO, WR-ALC, and the F-15 SPO, WPAFB, contained the JCALS and CMIS server applications and the JEDMICS API. The HP at the F-15 SPO, WPAFB, also contained the ECP data files. An HP 725 Model 100 at MDA was used outside of MDA's firewall to pass ECPs and TOs. Workstations loaded with the correct software suite to access the system were called universal access workstations (UAWs). The minimum configuration for the UAWs was a 486 computer, 33 MHz, with 16 megabytes of memory. The preferred configuration was a Pentium computer with 32 megabytes of memory. The TO project used 15-inch monitors and the ECP project used 17-inch monitors for reviewing drawings. Existing equipment was used when it met the above minimum criteria and supplemented when it did not.

For these projects, both the F-15 SPO, WR-ALC, and the F-15 SPO, WPAFB, were considered JCALS sites because they had JCALS servers located on site. MDA was not a JCALS site. This may change in the future if MDA wishes to become part of the

SPO's workflow. Seymour Johnson AFB, North Carolina, was a JCALS remote site because it did not have a JCALS server on site but, instead, logged into the JCALS server at WR-ALC to pass information or check on the status of a workflow process.

Connectivity for these efforts used Defense Information Systems Agency's (DISA's) Defense Information Systems Network (DISN). The F-15 has its own network, referred to as Eaglenet or the Electronic Co-location System (ECS). However for these projects, DISN was used exclusively. To connect MDA to the DISN, a T-1 link was needed. The Naval Aviation Depot, Cherry Point, North Carolina, already had a T-1 link between MDA and the DISN, so a memorandum of agreement between the F-15 SPO and Cherry Point was negotiated to support the project. Seymour Johnson was a typical operational base with its own connectivity challenges. It had local area networks (LANs) in two buildings which did not communicate with each other or outside the base. The base's only connectivity to the outside world was a partial T-1 line. DISA, as a partner in these

efforts, was called upon to provide the connectivity solution. The guidelines were that the solution had to be available for quick installation, inexpensive, and easy to install. DISA provided radio frequency (RF) links as the LAN solution which was appealing because it could be used for the project and, in the future, for deployments. These RF links networked several buildings and provided connectivity to the T-1. It was a solution that met all the criteria. Figure 2 shows the connectivity solution for Seymour Johnson AFB.

The ECP Project

The ECP project involved the linking of three sites: MDA, the F-15 SPO at Warner Robins, and the F-15 SPO at Wright-Patterson. The change process normally involves a lengthy negotiation phase between the SPO and contractor. This negotiation is known as the preliminary ECP phase. Because project guidelines only called for a one to two month demonstration, the preliminary ECP process was not captured. However, the same capabilities which support the ECP could also support the preliminary ECP. Likewise, the last stage of the ECP process which passes the approved ECP from the SPO to the contracting office was not included because electronic authentication/signature issues had not been worked out. This ECP project captures the process from the moment the contractor details the change in an ECP to the moment the Configuration Control Board (CCB) decision is recorded by CMIS.

Previously, ECPs for the F-15 were processed manually. That is, an ECP would come into the SPO in paper format and be

reproduced and passed around from desk to desk for coordination. ECPs needing coordination with Warner Robins were mailed to them and comments were sent back either by paper or telephone. Likewise, the CCB was conducted manually, with copies of evaluations, comments, and reports reprinted for board members' review.

The automated ECP project scenario began with MDA passing an ECP to the functional administrator at the F-15 SPO, WPAFB. The ECP was passed in SGML format using the portion of CMIS called the Multi-user ECP Automated Review System (MEARS). MDA placed the SGML ECP on the HP located at MDA and then notified the SPO that the ECP was available. The SPO downloaded the ECP to their HP via file transfer protocol (FTP) and then began the process of loading the ECP to the CMIS system using the MEARS system utilities. The ECP is parsed to validate that it complies with the MEARS ECP document type definition and SGML standards. The parsed ECP's indexes are then normalized and the linked SGML version of the ECP is saved to the SPO's HP with indexes recorded in the workfolder. Once loaded to CMIS, the functional administrator then placed the ECP into the appropriate JCALS workfolder to be passed around for review and approval by the appropriate people at both the F-15 SPO, WR-ALC, and the F-15 SPO, WPAFB as defined by the selected workflow template. This workflow identified reviewers and established review suspense dates and the date of the proposed CCB. The responsible integrated process team (IPT) leader was the first checkpoint in the workflow. The responsible IPT leader opened the workfolder and reviewed the

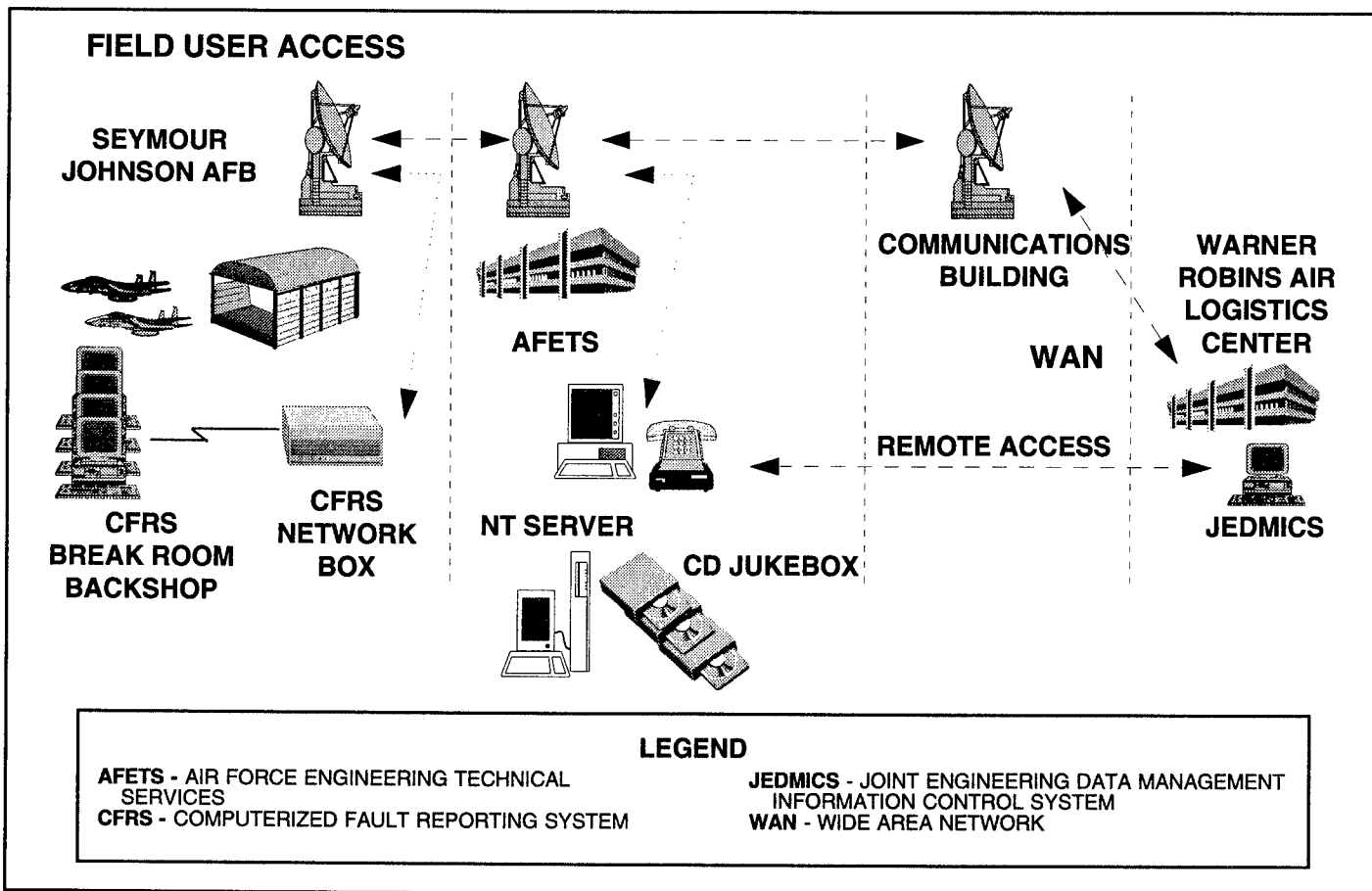


Figure 2. Seymour Johnson AFB Infrastructure

ECP to see if any other documentation needed to be added, such as drawings, TOs, or other ECPs. The ECP was then passed on to the reviewers, including other IPTs and functional areas who made comments and sent sub-workflows to their staffs, when appropriate. The responsible IPT consolidated all of the reviewers' comments and developed a position for the CCB. CCB members then reviewed the ECP from their respective functional areas and voted accordingly. These votes were recorded in the MEARS portion of CMIS.

The TO Project

The TO project linked MDA, the F-15 SPO, WR-ALC, and Seymour Johnson AFB. It supported two pieces of functionality. The first was the distribution of TOs from the contractor to the government and from the government to a field site. The second was the review and approval of a TO change request, also known as Recommended Technical Manual Change (RTMC) in JCALS parlance.

The previous TO process at Seymour Johnson began with a user documenting a recommended change using Air Force Technical Order Form 22, Improvement Request Form. The signed TO improvement form was then fed through a coordination process where the wing and MAJCOM consolidate it with similar requests and verified the need for improvement. Requests may have been returned because a previous request addressed the same issue, or the change was deemed not warranted. Disapproved TO improvement requests were returned to the user. Approved requests were forwarded to the Technical Order Management Activity (TOMA) for development. The TOMA or contractor developed a reproducible image for reproduction and dissemination. The TOMA, together with the Government Printing Office, reproduced the TO or its change pages and distributed them to TO distribution offices. The Technical Order Distribution Officers (TODOs), in turn, distributed the TOs to squadron level Technical Order Distribution Accounts (TODAs) who maintained the guidance material for the users. Maintenance included posting change pages to each copy of the TO assigned to the TODA.

The new scenario began with the delivery of TOs in both SGML and PDF format from MDA. For the purposes of the demo, MDA delivered seven illustrated parts breakdowns (IPBs) in SGML format and 385 TOs in PDF. The PDF files were initially indexed by the AF PDSM Office, but later deliveries were indexed by WR-ALC using the same indexing schema. Since Seymour Johnson AFB was not a JCALS site and only had partial T-1 line capacity to the outside world, it was determined that CDs provided the best media for distribution of TOs. The SGML IPBs were put on one CD and the remaining indexed portable document format (IPDF) files were delivered on another CD. The CDs were put on a CD jukebox attached to an NT Server which connected to the Seymour Johnson LAN. Adobe Acrobat and Exchange were used to view the IPDF files and InfoAccess was used to view the SGML files. Seymour Johnson pneudraulics, egress, sheet metal, repair and reclamation (R&R), metals technology backshops, and the ready room and flight support areas of the 333rd Fighter Squadron had access to the TOs.

The TO project scope began with MDA passing PDF TOs to WR-ALC for indexing and distribution. WR-ALC packaged the F-15E airframe TOs on CDs for distribution to Seymour Johnson AFB. The TODO at Seymour Johnson received and loaded the CDs on the jukebox attached to the TO server for distribution over the LAN. The technicians in the included backshops and ready rooms had access to both the SGML IPBs and the IPDF TOs. Both formats were used to determine in which situations SGML or IPDF provides more utility.

A Personal Computer Recommended Change (PCRC) application was installed on the Seymour Johnson personal computers because they were not a JCALS site and could not use the RTMC that is part of the JCALS software suite. PCRC enabled technicians to cut and paste out of a digital TO, make a correction, and submit the change to their supervisors. The supervisors, in turn, reviewed and submitted the change to the Product Information Officer (PIO) who routed it to the Quality Assurance office for approval before submission to WR-ALC. The PIO was also given the capability to remotely access the WR-ALC JCALS TO workflow to check its status. The workflow for PCRC started at Warner Robins where it was received by a central point of contact for TOs. This person reviewed the TO change, decided which technical content manager needed to review it, and established the workflow for recommended change approval. The approved TO change was then forwarded via e-mail to MDA to update the TO.

At the beginning of the project, a library of TOs on CDs was released to Seymour Johnson AFB. This TO CD library was called a block cycle release. Specific time frames for block cycle releases have not been established, but for project purposes another block cycle release was scheduled 45 days after the initial release. Unfortunately, changes had to be incorporated more frequently than the block cycle releases were delivered. These changes were made available via interim TO updates (indicating changes between block cycle releases). The interim TO updates were posted to an IBM computer at WR-ALC. The TODO checked the IBM daily to see if TO updates were available. If TO updates were posted, the TODO downloaded the new files to the TO server using FTP. The new files consisted of a new TO index file as well as new TOs. The new TO index overwrote the old TO index and pointed to the new information stored on the server's hard drive instead of the CDs.

Productivity and Affordability

There are several benefits to the SPO due to the ECP project. The JCALS/MEARS software developed specifically for this project enabled the user to review an ECP using MEARS and tailor a workflow to the business process. Prior to this effort, the ECP workflow was hard-coded in MEARS. A "virtual SPO" was created by linking the geographically separate SPO offices electronically to permit shared access to single information sources. Lastly, the infrastructure provided the capability to do contract change proposals (CCPs) as well as preliminary ECPs.

The TO project proved that the TO functionality could be extended to a non-JCALS site. This is important considering JCALS will not be implemented at all bases for several years. It also proved that bases with minimal infrastructure could have

relatively inexpensive communication solutions installed for immediate and long range use. The further value was that TOs were taken beyond the traditional TODO level into ready rooms and backshops for use by maintenance technicians.

Conclusions

The ECP and TO projects demonstrate that DoD systems and tools can be used effectively in an integrated data environment (IDE) to support the weapon system manager and the warfighter. From a technology standpoint, the projects illustrate the solutions available for both large and small bases, those with a modern infrastructure, and those that may not have the latest and greatest technology. The biggest challenge is expanding the scope of current programs to support the IDE. JCALS is a good example. The scope of JCALS needs to be expanded to provide infrastructure beyond the current technical manual functionality. These additional infrastructure requirements must be documented through the acquisition chain for appropriate funding so all bases can take advantage of the IDE concept.

There is much work to be done in exploring the IDE beyond the functionality demonstrated by these projects. In order to truly exploit the IDE, all functions supporting the SPO, whether inside or outside, must implement this environment. This necessitates the crossing of functional lines beyond the logistics arena, beyond service lines, and beyond government lines. Other important

functions include contracting, finance, and accounting. Similarly, Defense Logistics Agency item managers support the consumable item buys for all service weapon parts and there are single item managers who support buys for multiple weapon systems across multiple components. The supporting contractors must become part of the IDE in order to capitalize on the use of technical data at the source and the update of such data as weapons are fielded. All of these players must be part of the IDE infrastructure in order to reap the ultimate benefits of digitizing and sharing data.

The bottom line is that the IDE concept, through these limited applications, has proven its usefulness to the weapon system manager and the warfighter. The continued expansion of this IDE framework can only yield greater benefits and cost efficiencies.

Ms Wells is the Digital Data Project Manager at the Joint Logistics Systems Center (JLSC), Wright-Patterson AFB, Ohio. Mr. Wagner is the Division Chief for Deployment and Special Projects, also at the JLSC. The authors wish to acknowledge that this work was supported and funded by DUSD(L) and the JLSC. Special thanks to the F-15 customers at Warner Robins Air Logistics Center, Robins AFB, Georgia, Wright-Patterson AFB, Ohio, Headquarters Air Combat Command, Langley AFB, Virginia, and Seymour Johnson AFB, North Carolina, for their vision and their willingness to embrace the tools of the future.

JE

I am saying farewell as Editor of the *Air Force Journal of Logistics*. After serving in this position for over 4 1/2 years, and 22 years overall service to my country in the US Air Force, I am moving forward to a new phase in my life—a military retiree.

I truly believe the Journal has reached its intended audience and fulfilled its intended purpose—providing an open forum for the presentation of issues, ideas, research, and information about logistics matters. From the feedback I have received, the Journal is revered worldwide, not only from members of the US Air Force, but also from the militaries of other nations, industry, and academia.

It is very exciting to know the Journal is read at all levels of the Air Force—from the very highest, down to the individual logistician. The Journal is also being used as reference/source material in the nation's military academies, Air Force Reserve Officer Training Corps programs, and in Air Force and other Service's professional military education programs.

Tremendous effort by all was expended to achieve these results. I am deeply indebted to all the military and civilian authors who shared their knowledge and experience to make the Journal the most credible logistics magazine in the Air Force. I also want to thank the members of the Air Force Logistics Management Agency for their tremendous support and cooperation. Thanks also goes to the personnel at the Public Affairs offices, the Air Force Publishing Division, printing plants, and graphics, who contributed to the overall success of the Journal.

I appreciate the valuable comments, advice, and encouragement I received from all the Editorial Advisory Board members. I also appreciate the freedom I was given in producing the Journal.

I know the Journal will continue its tradition of excellence. I encourage our readers and brilliant logisticians to continue writing important, timely, and thought-provoking articles. I assure you, your efforts are appreciated by all.

Best Wishes, Lt Col Bruce Newell





CURRENT RESEARCH

Air Force Armstrong Laboratory Logistics R&D Program

The Logistics Research Division of the Armstrong Laboratory performs research and development (R&D) focused on technology for improving the performance of integrated systems of people, information, and equipment doing essential acquisition and logistics support functions in peacetime and wartime. This includes developing automated job aids and integrated diagnostics for maintenance information trade-off techniques and design tools for integrated product development that allows consideration of weapon system supportability and maintainability from design inception. Applications cover a broad spectrum of field, depot, and space operations with "customers" throughout the Air Force, Department of Defense (DoD), other government agencies, academic institutions, and US industry.

The following are brief descriptions of selected ongoing programs within this Division and is current as of November 1996. Readers interested in obtaining more information about these programs, future plans, or additional details about the Division are encouraged to call the individuals named for each work effort.

AIRCRAFT BATTLE DAMAGE ASSESSMENT AND REPAIR (ABDAR) TECHNOLOGY

OBJECTIVE: Enhance ABDAR capability of the Air Force by providing battle damage assessors, technicians, and engineers with quick and easy access to assessment and repair information.

APPROACH: A contracted research effort began in August 1995 and will be accomplished in four major phases. In Phase I, a requirements analysis was performed to identify information required by assessors and engineers to assess damaged aircraft. Phase II, currently in progress, involves designing the ABDAR demonstration system, based on the requirements defined in the Phase I study. The design will focus on providing ABDAR information to the user through a portable maintenance aid (PMA). The PMA will contain all of the information required by the user including assessment and repair logic, technical orders, part information, wiring diagrams, schematics, and troubleshooting data. A graphical user interface will allow the user to easily access and comprehend ABDAR information. The Phase III effort will involve implementing the software design, authoring technical data, and integrating the system. Data for a specific test-bed aircraft will be developed for presentation on the PMA. Finally, Phase IV will involve final system enhancements and testing to evaluate system effectiveness and user acceptance.

EXPECTED PAYOFFS: Fast and accurate battle damage assessment and repair will lead to improved combat effectiveness by reducing the time to get aircraft back to mission capable status. Less experienced users will have better access to ABDAR information reducing the reliance on highly trained assessors. Deployment capabilities will be enhanced by minimizing the amount of paper technical data and supporting information

presently required by the user. (Capt Michael Clark, AL/HRGO, DSN 785-2606, (513) 255-2606, mclark@alhrgr.wpafb.af.mil)

LOGISTICS CONTINGENCY ASSESSMENT TOOL (LOGCAT)

OBJECTIVE: Demonstrate new technologies and processes to improve the deployment planning process, reduce deployment footprint, reduce deployment response times, and use deployment resources more efficiently and effectively.

APPROACH: The Logistics Contingency Assessment Tool (LOGCAT) is a vision for improved wing level deployment planning and replanning. Currently, the LOGCAT Vision is comprised of four integrated initiatives, Survey Tool for Employment Planning (STEP); Unit Type Code Development, Tailoring, and Optimization (UTC-DTO); Beddown Capability Assessment Tool (BCAT); and Logistics Analysis to Improve Deployability (LOG-AID). STEP will use advanced integration of computer hardware and software to automate the collection, storage, and retrieval of deployment site survey information. STEP consists of three major subsystems: a suite of computerized and multimedia site survey data collection tools, a deployment site knowledge base, and a graphical and collaborative user interface for retrieving information from the deployment knowledge base. UTC-DTO will use advanced software to automatically develop UTCs, automatically tailor UTCs based on individual deployment scenarios, and optimize the packing of UTC equipment onto 463L cargo pallets. BCAT will use advanced database design to compare deployment site force beddown capabilities against deploying forces beddown requirements and produce a list of resource shortfalls. LOG-AID will analyze the deployment process firsthand to define requirements, identify additional opportunities to improve deployment planning processes, develop additional tools where appropriate, and integrate them with the BCAT, STEP, and UTC-DTO tools to form a demonstration deployment planning system. The deployment planning demonstration system will then be tested under field conditions.

EXPECTED PAYOFF: Improved wing level deployment planning and execution will increase Air Force combat capability. Reducing mobility footprint will reduce requirements for scarce airlift assets, enabling deployment of additional combat capability. Reducing deployment response time will increase the deterrent effect of our military forces on distant enemies and allow US policy makers to respond more quickly to aggressive actions of distant enemies should deterrence fail. More efficient and effective use of mobility resources will allow the Air Force to maximize its power projection capabilities. (Capt Scott Harbula, AL/HRGO, DSN 785-2606, (513) 255-3771, sharbula@alhrgr.wpafb.af.mil)

INTEGRATED TECHNICAL INFORMATION FOR THE AIR LOGISTICS CENTERS (ITI-ALC)

OBJECTIVE: Improve, standardize, and integrate technical and managerial information, and make it more readily available

at the job-site to improve the performance of aircraft programmed depot maintenance (PDM) activities.

APPROACH: This effort has two phases. In Phase I, a detailed requirements analysis of current PDM operations at all Air Force ALCs was completed. The focus of Phase I was on PDM with a limited evaluation of assemblies, modules, and units. Information modeling was used to develop "as-is" and "to-be" functional, data, and process models that represent PDM operations and information requirements. Dynamic simulations were used to investigate process changes and improvements. Products from the Phase I effort include an architecture report documenting the results of a depot-level requirements analysis, a business case in which depot process improvements have been identified, functional specifications, and a top-level design for an integrated information capability. Phase I was completed in April 1996. Phase II will use the results of the requirements analysis phase to design, develop, and test a demonstration-level integrated maintenance information capability for supporting PDM activities. Phase II activities will push the state-of-the-art by evaluating new diagnostic techniques, creating advanced presentation schemes for graphics, employing new database approaches, and testing advanced hardware and software technology. Phase II started in December 1996 and will be completed by September 1999.

EXPECTED PAYOFF: Payoff to the Air Force will include specifications for developing a full-scale, depot-integrated maintenance information system for operational use. In addition, the ITI-ALC effort will be providing the ALCs with an independent review of the current PDM process and possible changes or areas for improvement, to increase efficiency, lower operating costs, and improve technician performance. (Capt Robert Hartz, AL/HRGO, DSN 785-3871, (513) 255-2606, rhartz@alhrq.wpafb.af.mil)

INTEGRATED MODEL DEVELOPMENT ENVIRONMENT (IMDE)

OBJECTIVE: Improve the quantity, quality, and timeliness of information based on logistics simulations.

APPROACH: Using commands have ongoing initiatives which are investigating ways of improving their simulation capabilities; however, these programs have taken an incremental approach. This project has taken a much more aggressive approach. State-of-the-art data management, user interface, and modeling methodologies are being incorporated into the IMDE demonstration system. The goal is to "leap ahead" and demonstrate simulation capabilities far beyond what is currently available. US Army, Navy, and Air Force organizations who utilize simulation in decision support studies, as well as Armstrong Laboratory scientists, will evaluate the utility of the IMDE tool. Work has been ongoing for four years, with results exceeding expectations. The system is currently being expanded to evaluate enhanced capabilities through the use of expert systems, distributed interactive simulation, parallel simulation, and dynamic plan interpreter extensions.

EXPECTED PAYOFF: Easier-to-use modeling and simulation software tools will dramatically shorten the time necessary to develop and support quality analytic models. The IMDE system has proven in multiple studies to dramatically reduce the simulation development life cycle while greatly

enhancing simulation capabilities. (Capt Todd Carrico, AL/HRGO, DSN 785-2606, (513) 255-2606, tcarrico@alhrq.wpafb.af.mil)

LOGISTICS CONTROL INFORMATION SUPPORT (LOCIS)

OBJECTIVE: Provide logistics personnel at all levels with proactive access to real-time accurate information needed for decision support.

APPROACH: Currently, there are several command and control systems in use or in development that provide senior decision makers access to consolidated data. Unfortunately, the data has to be interpreted and prioritized by subject matter experts before it can be forwarded to the senior decision makers for action. LOCIS is focusing on utilizing existing legacy and command and control systems coupled with state-of-the-art information technology to provide field users at all levels a proactive decision support system with access to real-time accurate information. LOCIS will employ automated techniques to gather data (including remote sensors to track movement of resources), data mining to extract information from divergent data bases, and intelligent agents to assemble and evaluate information and report it to the user.

EXPECTED PAYOFF: LOCIS will provide logistics personnel the information and tools they need to better perform their duties. Through the use of real-time accurate information and the application of advanced decision aids, logistics personnel will be more effective in the day-to-day use of their assets and in short-notice deployment operations. (1 Lt Keith Shaneman, AL/HRGO, DSN 785-3871, (513) 236-9328, kshanema@alhrq.wpafb.af.mil)

DESIGN EVALUATION FOR PERSONNEL, TRAINING, AND HUMAN FACTORS (DEPTH)

OBJECTIVE: Provide a tool to assess maintenance while design changes are relatively simple and cost-effective to make. Facilitate the logistics support analyses (LSA) process by automatically storing key support requirements data generated by the maintenance simulations.

APPROACH: On a new design, many problems can be detected only after an expensive physical mockup is built. At this point it is often too late in the development process to make significant changes. Consequently, opportunities are missed to reduce long-term costs, increase availability, and improve safety. DEPTH will facilitate maintenance assessment during design by simulating tasks on "virtual mockups" originating from computer-aided design data. Using animated 3-D models of humans, designers can analyze tasks in a variety of situations with respect to accessibility, visibility, and strength. Using accurate anthropometric and ergonomic data from another Armstrong Laboratory program called Crew Chief, DEPTH has the capability to simulate full maintenance tasks using advances in visual simulation. From simulation results, LSA records (personnel, tooling, task times, spare parts, and other relevant information) can be updated automatically. DEPTH was developed with input from the ALCs, industry, and the B-1, F-15, F-16, and F-22 system program offices (SPOs).

EXPECTED PAYOFF: The most significant cost savings come after a weapon system is fielded with streamlined repair

procedures—an estimated \$1.2 million annually for a deployed wing of F-15s and F-16s. Readiness can be increased by ensuring removal and replacement of critical components is safe and not obscured. DEPTH can also reduce acquisition costs by providing an alternative to physical mockups and improving the LSA process. The simulations can be used by SPOs and ALCs to verify LSA data including safety, support equipment, hand tools, manpower, personnel, and training. The logistics data capture will cut costs by providing a direct link between the simulation and the LSA database. Animations from DEPTH can also be used for training and electronic technical manuals. Although the program emphasizes military aircraft maintenance, the DEPTH technology can be readily applied to many other situations such as control center layouts. Hence, this software is already suited for multiple applications. (Mr John D. Ianni, AL/HRGA, DSN 785-1612, (513) 255-1612, jianni@alhrg.wpafb.af.mil)

REQUIREMENTS ANALYSIS PROCESS IN DESIGN FOR WEAPONS SYSTEMS (RAPID)

OBJECTIVE: Enable more efficient and accurate definition, analysis, and management of weapon system requirements as an integral part of the systems engineering model of acquisition.

APPROACH: The RAPID project approach includes 10 months of data gathering and evaluation; 15 months of design, implementation, and initial demonstration; and 20 months of researching extensions, such as expert system technology and internal consistency checking of requirements assertions. Phase I was a period of model building, determining RAPID user needs, and conceptualizing RAPID use. Initial software design efforts included evaluating off-the-shelf software, selecting a basic hardware/software platform and operating system, and arranging field demonstrations. Phase II is oriented to coding, testing, and user validation of both the concept and the software. During Phase III, users will conduct a demonstration and participate in the definition of extensions to the basic requirements management software. Expected extensions include refining the knowledge base foundation and evolving a distributed access design to serve the needs of geographically separated action officers and their acquisition counterparts.

EXPECTED PAYOFF: RAPID offers the potential of reducing the effort of producing operational requirements documentation. Through the use of technology and data standardization, operational requirements may also be checked for internal consistency and external consistency with other modernization processes. This software application is intended as a model for further development of systems in present use. RAPID offers a platform for the development of theoretical constructs that can be extrapolated, for example, fine grained version control and the collaborative development process. (Ms Janet L. Peasant, AL/HRGA, DSN 785-8502, (513) 255-8502, jpeasant@alhrg.wpafb.af.mil)

SUPPORT EQUIPMENT EVALUATION/IMPROVEMENT TECHNIQUES (SEE/IT)

OBJECTIVE: Analyze problems and determine potential solutions and technology shortfalls pertaining to aircraft support equipment (SE) in general and aerospace ground equipment (AGE) in particular.

APPROACH: This exploratory research and development effort contains four data gathering and analysis tasks. The first

task identified and documented usability, reliability, maintainability, supportability, and deployability (URMS&D) problems associated with deployable AGE and related SE. These problems ran the gamut from individual end-item type problems to problems affecting AGE processes and systems in general. The second task will include identifying and documenting technologies and processes to provide solutions for the problems. The results of these first two tasks will include documented technology shortfalls. The third task will require analyzing the solutions to determine the costs and benefits related to each solution. The benefits will be based on comparing “as-is” and “to-be” metrics in the cost and “ility” areas. The results of the third task will feed a combinational analysis performed in the fourth task to define the best combination of solutions. The result will be a set of potential AGE modifications and technology insertions to improve the URMS&D of AGE.

EXPECTED PAYOFF: This effort will result in documented AGE problem areas based on user input. In addition, previously undefinable technology shortfalls will be found and documented. Finally, the simulations and analyses will result in one or more recommended Air Force actions including AGE modifications, AGE procurements, and laboratory research programs with documented cost and benefit analyses for each action. (Capt Dwight Pavak, AL/HRGA, DSN 785-9651, (513) 255-9651, dpavak@alhrg.wpafb.af.mil)

MODULAR AIRCRAFT SUPPORT SYSTEM (MASS)

OBJECTIVE: Evaluate and test alternative ways of packaging aircraft ground power functions.

APPROACH: At present, aircraft maintenance and servicing needs are supported by single-function carts such as generators, air conditioners, hydraulic mules, light carts, etc. Among other problems, the current approach to flight line powered support equipment imposes a deployment penalty. A modular approach to support equipment would allow multifunctional carts to be created. Packaging support equipment functions in versatile carts would substantially reduce the logistics footprint for deployment. The research will identify and rank a series of support equipment options. Candidate MASS configurations will be defined in league with users and evaluated with respect to engineering feasibility, aircraft applications, affordability, and deployability. We will use current support equipment performance, supportability, and cost profiles to benchmark improvements that might be expected from modular support equipment. One or more MASS technology demonstrators will be fabricated and tested in the field. The design approach will emphasize supportability of the MASS equipment using computer-aided design tools.

EXPECTED PAYOFF: Converting to multifunction from single-function support equipment will directly reduce air mobility footprint. Air Force Materiel Command guidance on Reliability, Maintainability and Deployability (RM&D) suggests the value of technology innovations be measured where feasible in airlift pallet positions saved. The MASS concept would eliminate up to three C-141 sorties in moving a composite wing. (Mr Matthew Tracy, AL/HRGA, DSN 785-8360, (513) 255-8360, mtracy@alhrg.wpafb.af.mil)

Forging Partnerships Through Listening, Understanding, and Leadership

Harold B. Crapo, Jr., CCP

Introduction

Do you have confrontations at work, argue with your spouse, or have difficulty with your relatives or neighbors? If so, just maybe you are managing to listen without understanding what is really taking place. We are supposed to listen twice as much as we speak. This is one of the reasons I believe why we were given two ears and the intelligence to process what we hear. But listening is not enough.

When you can repeat back to me, in your own words, to my satisfaction, what you believe I said to you, then and only then, have we communicated. If that is not "forging a partnership," then somehow I have gone astray and failed to understand a couple of definitions. For example, Webster defines forging as "giving shape to" and partnership is described as "agreement." (3) Now, one might conclude "giving shape to an agreement" might fit in very nicely with any professional discipline such as dentistry, human relations, and logistics. For example, just imagine sitting in the dentist's chair during the process of having a root canal and you realize that the doctor is not able to communicate with the dental technician. Ouch! Think of the logistician that is not able to communicate with the engineer while they discuss writing of technical orders based on the engineer's assembly and control drawings. Both situations can be extremely painful, depending upon your relevant position. This paper is intended to show you that forging partnerships through listening, understanding, and leadership affects each and every one of us, no matter what our profession or trade. And yes, it takes more than just management—it takes leadership.

Leadership

We shall skip the full classical definition of management, part of which is to direct and control. Instead, we shall briefly discuss leadership. Leadership becomes extremely important in any profession, especially where communication is involved. Leadership requires people who are willing to do the right things instead of always doing things right. Leadership requires listening and understanding. It is not sufficient to believe merely because you as a manager have silenced someone, the person has been convinced. It merely indicates that trouble may lie ahead. Leaders have to listen and take the time to understand in order to be effective in their environment. Please notice listening (gathering data), is mentioned before understanding (processing and analysis), which is required for information to become reliable and useful.

Listening, according to the dictionary, means "to hear, to pay attention to sound." Nothing is to be construed in the definition as to understanding. Instead, the definition relates only to sound.

Understanding, according to the same dictionary, means "to grasp the meaning of, to accept as a fact or truth, or regard as plausible with utter certainty; the power of comprehension; to achieve a grasp of the nature, significance, or explanation of something." (3) Therefore, merely nodding one's head in agreement does not convey understanding, nor does it convey communication has taken place. Acknowledgment in this manner can only signify an audible or visual exchange has been noted—nothing more, nothing less.

Process of Listening

Frequently, the recipient of a verbal message has engaged their thinking powers in an attempt to answer questions that have not yet been asked, while the other person is trying to communicate by conveying a thought. In other words, the receiver of the message is just listening, not understanding. Understanding requires verifying, evaluating, formulating a reply, and then conveying a response to the message received. People who engage in this type of verbal exchange, manage to ensure breakdown in communication exists. Note how the use of the word "manage" was worked into this. We who make constant efforts to communicate, whether vocally, in writing, or other signed language, should strive to become "leaders" in communication. This means we must listen; understand; confirm our understanding; use our inherent capabilities to think, evaluate, formulate ideas; and then convey our thoughts back to the sender of the initial message. What a process! It sounds like this process could be extremely time consuming, but it really is not all that bad. There are tools available that can help us in this most important area of communication. Now, we will take a look at one of those tools.

Conceptual Schema

This tool was developed many years ago. Figure 1 is simplistic in design, easy to understand, but requires the user to adopt and use a discipline to help ensure understanding takes place. The schema can be used to resolve conflicts in the work environment, in public, at home, and among relatives. Oh yes, most of us have experienced, at one time or another, conflicts at work or at home. And if we stop and take the time to reflect upon the incidents, most of the time we can attribute the problems to a lack of listening and understanding what was really taking place. For example, can you recall when you may have been at a meeting where the attendees were there for the prime purpose of participating and contributing to accomplish a common goal? Perhaps you observed or became involved in a strong exchange of words, or multiple conversations were going on at the same time. You can be assured that nothing of value took place or was

decided in that type of environment. It is true a verbal exchange may have taken place, but communication probably took on a negative connotation through the observance of displayed emotions rather than words that were spoken. It is precisely at times like this that you as an individual, armed with the knowledge and discipline to exercise the precepts of the schema shown below, can make a difference.

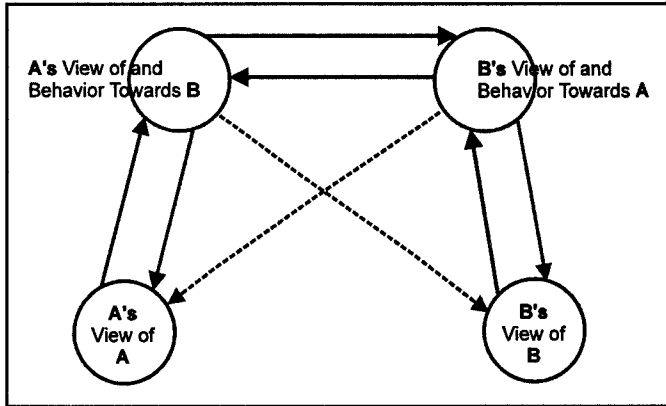


Figure 1. Conceptual Schema (1)

Using the Conceptual Schema

If you closely follow the model and construct a matrix for your answers, it can become readily obvious where a breakdown in communications can occur. If you plan to try out the conceptual schema shown above, you must first prepare a matrix with four columns (see Table 1). The number of rows will depend upon how creative you choose to become. Your next step will be to place headings at the top of each column.

The headings will match each one of the circles shown in the diagram. For example, you may choose to number them from 1 to 4 representing the text associated with each circle or you may enter the text for readability, as shown in Table 1. You must take the leadership role and identify yourself as "A" because you are the initial evaluator interested in finding out why certain people do not seem to understand what you have to say, for example, in meetings.

Data Collection

First, you should list all of the views you have towards the person that you appear to have a conflict with, including your behavior towards them, as you see it. A brief example is shown in Table 1. And remember, list the good as well as the bad about

yourself, not just your adversary. If you must, list all of the negative things about your perceived antagonist and then list at least an equal number of positive aspects about the same individual. This may take some doing, but be assured the results are worth the effort. Of course, you will be expected to do the same thing for yourself, but probably in the reverse order. So let us start with you, person "A," in the first column of the matrix. After you have exhausted your findings in the first column, proceed to fill in the second column with what you believe person "B" thinks of you and the behavior displayed toward you. Remember, we are dealing with human emotions and perceptions. However, these perceptions can be most revealing when they are analyzed, evaluated, and put back into perspective. So let us try it.

Start filling in the second column. Oh yes, as you fill in each column, do not hesitate to go back to the first column and fill in extra descriptions which you think are appropriate. Now it is time for the third column to be filled in. What do you think of yourself? Do not be bashful at this stage, because no one else is going to see what you have to say. However, if you are less than honest, then an analysis of all of the data will be useless. After you have completed the third column, you must really reflect and try to empathize with person "B" and list the positive and negative items you believe the other person thinks of himself or herself. You are correct; you can not possibly think for another person, but remember, if you have been listening, as you say you have, then the other person has left a lasting impression you are trying to understand. After you have finished with your data collection process, it is time to start analyzing and comparing your findings in an effort to determine where there are disconnects.

Data Analysis and Evaluation

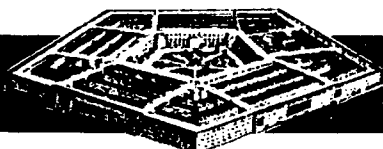
Follow the lines with arrows shown on the conceptual schema above, to help you with your comparisons. Do not rule out environmental impacts such as personal and family life, likes and dislikes. This part of the evaluation is not necessarily easy. It takes a truly understanding person to go through this process, which is only one of the attributes that separates the managers from the leaders.

Once you have gone through the painstaking process of analyzing and evaluating the data, you should have a rather impressive collection of information that will help you formulate solutions towards forging partnerships—whether you are involved with logistics, engineering, or just trying to understand the difficult uncle or sister-in-law everyone else, correction, almost everyone else, seems to dislike. I believe almost everyone is motivated to do their best at whatever they attempt to do.

(Continued on bottom of page 23)

A's View of and Behavior Toward B	B's View of and Behavior Toward A	A's View of A	B's View of B
B-Educated	A-Aggressive	Organized	Explains Issues
B-Arrogant	A-#%*&@%?^	Competent	Well Liked
B-Impatient	B-Frustrated	Educated	Sociable
B-Does Not Listen	A-Dogmatic	Well Mannered	Superior
B-Talks Too Much	A-Too Detailed	Sometimes Impatient	Very Intelligent
B-Fairly Well Liked	A-Over Dressed	Listens Well	Polite
B-Poorly Dressed	A-Educated	Understanding	Good Manager

Table 1. Behavioral Matrix



Hazardous Materials Management

On 31 May 1995, the Deputy Chief of Staff, Logistics (HQ USAF/LG) signed an organizational change package (OCP) legitimizing Hazardous Materials Pharmacies (HMPs) within the objective wing structure. The OCP placed cross-functional HMPs under a flight in base supply, since base supply was viewed by most as the single source for all materials. Since that time, and even before, our installations have been attempting to capture information on hazardous materials (HAZMATs) coming onto installations from all sources and where it is being used. They are doing this to comply with Executive Order (E.O.) 12856, Federal Compliance With Right-To-Know Laws and Pollution Prevention Requirements. The ultimate goal is to protect the health of people, both on base and in surrounding communities, and the environment in which they live and work.

Less than a year after HQ USAF/LG signed the OCP, major commands (MAJCOMs) and installations began elevating problems associated with instituting pharmacies. As a result, the Air Force Inspection Agency (AFIA) conducted a functional management review (FMR) of HMPs. The purpose of the FMR was to evaluate the organizational and operational effectiveness of pharmacies and their ability to effectively minimize hazardous wastes, protect the health of the work force, and provide timely mission support. The cross-functional FMR team visited 47 organizations across ten MAJCOMs and evaluated policy and guidance, base-level training, staffing and organizational structure, procedures, processes, and facilities. Additionally, they identified those best practices observed.

The team cited nine major findings and three observations in their 20 June 1996 report (PN 96-606). Deficiencies impacting HMP operations exist in every area evaluated ranging from inadequate policy, training, and facilities to a lack of cross-functional expertise. Additionally, the team's report highlighted two particularly interesting facts. First, successful HMPs require support and cooperation of all units on an installation, especially each source of supply, the Civil Engineering (CE) Environmental Flight, the Bioenvironmental Engineering Flight, the Contracting Office, and Wing Safety. Second, the Standard Base Supply System (SBSS) has eroded as the single source of supply, as alternate sources of supply and customer created supply systems have grown over the past 15 years. Most notable is CE with the Civil Engineer Materiel Acquisition System (CEMAS), Contractor Operated Civil Engineer Supply Store (COCESS), and Government Operated Civil Engineer Supply Store (GOCESS) and vehicle maintenance with the Contractor Operated Parts Store (COPARS) and Government Operated Parts Store (GOPARS). The erosion continued as the International Merchant Purchase Authorization Card (IMPAC), Standard Form 44, Purchase Order-Invoice Voucher, and blanket purchase agreements (BPAs) drastically reduced items ordered through SBSS. Furthermore, HAZMATs enter installations through contractors, transient aircraft, deliveries to the Defense Reutilization and

Marketing Office (DRMO) from off-base organizations, and numerous other sources. In most cases, no one processes these items through base supply. Therefore, the items never become part of the SBSS database. **As a result, the majority of our HMPs do not capture information on a large portion of HAZMAT entering our installations and thereby fall short of what is required by Executive Order 12856.**

To address the findings and ensure we are in compliance with E.O. 12856, the Air Staff tasked the existing cross-functional Weapon Systems Pollution Prevention Integrated Process Team to determine what is required to manage HAZMAT, cradle to grave, on Air Force installations. Since beginning their effort in April 1996, the team, working with MAJCOM points of contact, has developed a definition for HAZMAT (for tracking purposes), identified minimum requirements for managing HAZMAT, and developed HAZMAT management indicators. The Air Staff will publish an Air Force Instruction (AFI) on Hazardous Material Management after the Air Force Environment, Safety, and Health Committee (formerly Environmental Protection Committee) determines who should oversee the cross-functional HAZMAT management process.

Finally, the Air Force Inspector General (SAF/IG) prepared an Air Force Special Interest Item (SII), SII 97-001, Hazardous Materials Management. The SII is a direct result of the FMR and its inspection period is from 1 November 1996 through 31 October 1997. It will help access the requirements for the identification, storage, handling, use, and disposal of hazardous materials. Anyone interested in obtaining a copy of the FMR report may call AFIA at DSN 246-1639. Those interested in obtaining a copy of the SII should call their MAJCOM/IG. (Lt Col Judyann L. Munley, HQ USAF/ILMM, DSN 225-5583)

The Express Movement Initiative

Have you heard of the Express Movement Initiative (EMI)? Falling under the Deputy Chief of Staff, Installations and Logistics (HQ USAF/IL) Lean Logistics (LL) umbrella the EMI is one facet of the Headquarters Air Force response to the Department of Defense's (DoD's) 1996 Logistics Strategic Plan. The DoD plan directs all Services to reduce logistics cycle times. Translation—the DoD wants the Air Force to get spare parts—both repairables and consumables, to you—faster! The DoD focus is not only to improve customer support, but also to reduce Air Force inventories, as less inventory will be needed to support shorter pipelines.

So, what is the EMI? And, who are the key players? The story goes something like this. The EMI involves the express movement of all routine stock replenishment repairables (which in the logistics community are also called Depot Level Repairables (DLRs) or Repairable Support Division (RSD) items), selected routine stock replenishment consumables (which are also known as economic order quantity or General Support Division (GSD) items), and all retrograde spares, (which are broken

reparables shipped from bases across Air Force to a source of repair). Let us take each of these categories one at a time and introduce the key players as well.

Reparables. What will move is pretty straight forward. All reparables will be moving worldwide via express commercial carrier. Excluded will be "hard-to-service" areas, such as Turkey and the Azores, where customs problems and the lack of commercial carrier availability preclude commercial express movement. To make this happen the Headquarters Standard Systems Group (HQ SSG) will embed a project code of "780," a Required Delivery Date (RDD) of "777," and a priority of "08," on all routine stock replenishment requisitions in the Standard Base Supply System (SBSS). The SBSS will then pass this information to both Air Force Materiel Command's (AFMC's) Stock Control and Distribution (SC&D) System and the Defense Logistics Agency's (DLA's) Distribution Standard System (DSS). Once these systems get this information, AFMC and DLA key on it to move reparables express. Implementation is anticipated in early 1997.

Consumables. The express movement of consumables is working similarly to the express movement of reparables. HQ SSG has embedded the necessary information into the SBSS that DLA's system responds to. The key distinction between the express movement of consumables and the express movement of reparables is that only **selected** stock replenishment consumables are moving fast (shipping everything proved too cost prohibitive). Those consumables moving fast are identified on the basis of an Air Force Logistics Management Agency cost-to-hold versus cost-to-ship economic benefit heuristic, which has been encoded into the SBSS. The EMI for consumables began 1 October 1996.

Retrograde. Lastly, **all** retrograde will move fast back to sources of repair. Again, based on key data elements, data will be flowed through the SBSS to the Cargo Movement Operations

System (CMOS). The local transporter will then key on CMOS output to ship the retrograde by commercial express carrier. Anticipated implementation is early 1997.

The EMI is the Air Force effort to move parts with "time definite" delivery. Working in partnership with DLA, EMI is focused on improving support to the warfighter while at the same time "leaning" logistics inventories. (Lt Col David M. King/Capt Monte J. Murphy/Mrs Patricia A. Cronin, HQ USAF/ILSY/ILSP, DSN 227-2209/225-2409)

Sustainment Executive Management Report (SEMR)

The Sustainment Executive Management Report (SEMR) is a semiannual assessment by system program directors and single managers of their system which they send to the Deputy Chief of Staff, Installations and Logistics (HQ USAF/IL), Headquarters, Air Force Materiel Command, and using commands. The report is based on a number of core indicators assessed for the current and projected years. "SEMR97" is an enhanced report that uses the SEMR as a base and replaces the Weapon System Program Assessment Reviews (WSPARs). SEMR97 will be an Air Staff decision-making tool used to assist the Air Force Corporate Structure during the Planning, Programming, and Budgeting System (PPBS) process. The information provided through SEMR will be available to the Air Force Corporate Structure, to include the mission panels and weapon system integrated process teams, via a Corporate SEMR 97 briefing. The draft SEMR Air Force Instruction (AFI) and process guide are currently in coordination. There is a SEMR home page located on the World Wide Web at: <http://www.afmc.wpafb.af.mil/organizations/HQ-AFMC/DR>. (Lt Col Lori Gaston, HQ USAF/ILMY, DSN 227-9179)

(Continued from page 21)

However, some of us just have a different way of going about accomplishing our tasks, much to the chagrin of those who do not take the time to listen and try to understand.

Communication Exercise

There are other ways of demonstrating how difficult it is to communicate with each other. For example, draw a particular picture or diagram on a piece of regular paper. Do not show the paper to anyone else. Select an individual to participate in an exercise with you. Set up two straight backed chairs back-to-back. You then ask your partner to sit in one chair with a pad and pencil while you sit in the other chair with your backs toward each other. Your task is to describe to your partner the picture or diagram that you have drawn. Your partner is not allowed to ask any questions other than for you to repeat your instruction. When you believe that the drawing should be complete, compare notes. Did you communicate? Could the same type of results be found when the logistician or the engineer does not communicate during the development of technical orders?

Summary

The Society of Logistics Engineers identifies logistics as "the art and science of management, engineering, and technical

activities concerned with requirements, design, and supplying and maintaining resources to support objectives, plans, and operations." (2) I am unable to imagine "the art and science of management, engineering, and technical activities..." without forging partnerships through communications.

Forging partnerships through listening and understanding takes leadership. And when it comes time to accomplish a task requiring more than one person, then we should make every effort to forge our partnerships in order to work as a team. Effective communication is the key element towards successful accomplishment of anything we undertake and that definitely takes leadership.

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JL

AFIT's Graduate Education—The Air Force's Intangible Competitive Edge

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Introduction

The Air Force has long recognized the value of quality education, as is evident from the following axiom stated in Air Force Manual (AFM) 1-1, *Basic Aerospace Doctrine*: “success in war depends at least as much on intellectual superiority as it does on numerical and technological superiority.” (3) And, in this era of right-sizing and trying to do more with less, the oft-uttered phrase “work smarter, not harder” seems to underscore the importance of education. In other words, the Air Force’s competitive edge in the future, both on and off the battlefield, will depend in a large measure on that part of the human anatomy that rests on a person’s shoulders.

For the logistician, this would appear to be particularly applicable, given the direction in which the Air Force (and the other Services as well) is headed. In the words of the Secretary of the Air Force and the Air Force Chief of Staff, the Air Force faces a period of profound change. (1) Although it is easier to explain the past than to predict the future, there are some assumptions that can reasonably be made about certain aspects of this change. In the future, the activities involved in executing the Air Force’s mission will become more diverse and complex and may involve operations in what have previously been nontraditional areas. While the Air Force of the future will most likely not get any larger, based on the experience of the last few years, the tempo of operation will likely be faster paced and less predictable than in the old Cold War environment. Forces may be deployed more frequently, and under the new Air Expeditionary Force concept, they will probably be deployed in smaller, nonstandard unit-equipped sized deployment packages. (5) Advanced technology, in the form of weapon systems, information management, etc., will play ever more prominent roles, and in all cases, we will have to provide reliable, flexible, prompt, and cost-effective support to the warfighter.

In concert with a high operational tempo though, are the enormous pressures to reduce defense spending as a component of deficit reduction and budget balancing. Yet, as a result of a decade of steady decline in the defense budget, much of the activity surrounding what budget authority is available will involve how to actually ramp up spending that can be allocated to force modernization. (14) Acquisition reform and technology will play a significant role in how we acquire new weapon systems for this modernization, and revolutionary initiatives such as Lean Logistics will be implemented to support both our current and future forces more efficiently and effectively. Most recently, the Chairman of the Joint Chiefs of Staff published *Joint Vision*

2010, his template for the operational evolution of the Armed Forces. *Joint Vision 2010* describes the emergence of four operational concepts which will be central to the Armed Forces’ successful dominance across the full range of military operations. Significantly, one of the four new concepts is “focused logistics.” (8)

Logistics functions will not be exempt from increased right-sizing and budgetary pressures as we attempt to improve support to the warfighter while achieving a leaner infrastructure. Additionally, those activities which occur away from the flight line will be closely scrutinized for privatization and outsourcing. The result of all this will lead to changes in the size and composition of the force, as well as certain activities performed by those personnel remaining in uniform. The mission of the Air Force, although it may appear to look different, will endure or perhaps even grow. Therefore, a smaller number of individuals will be expected to perform a larger number and greater variety of tasks and duties, and have less time to prepare for them.

There will be a pressing need for a force multiplier to help ensure our success in the future, both on and off the battlefield. And this will be true not only for the logistics career field, but for all aspects of the Air Force. Leaders of tomorrow’s Air Force will need the intellectual acumen to “name that tune” after hearing just two or three notes. This paper will discuss graduate education as a component of the force multiplier, and the Air Force Institute of Technology’s (AFIT’s) role in providing that graduate education.

Education and Technology are Force Multipliers

The most effective force multiplier is really a multivariate equation consisting of: (1) an able, motivated, and well led work force; (2) that has been given appropriate training and education; and (3) that is supported by state-of-the-art technology. (10) A small force leveraged by the above mentioned enabling factors can defeat a much larger force that lacks one or more of these elements. The Israeli experience since 1947 and the US and Coalition defeat of a larger Iraqi force in the Persian Gulf War constitute two excellent examples of the power of the force multiplier equation.

The concept of education as a “force multiplier” has broad general applicability and is not unique to just the military. For instance, an analogy can be drawn between the future need for this force multiplier by the Air Force (including its logistics support), and the need for a similar force multiplier by the US economy to remain healthy and competitive in the future. Simply

put, success for both will depend on a qualitative rather than a quantitative edge. The Air Force is moving to a smaller, higher technology force, where success logistically will be a result of qualitative rather than quantitative factors. On the economic front, the US cannot compete with China, India, Indonesia, Mexico, and other developing nations as far as labor intensive industries are concerned. (6) If the US is to enjoy a promising economic future, it must concentrate on high technology, knowledge intensive industries. These industries require a well-educated, technical work force (the force multiplier). Without this, the US will lack a competitive edge, and wind up exporting its wealth to more productive nations. (4) This is why so many successful companies emphasize the value of a quality education, and why so many of their personnel groups offer or sponsor educational benefits for their employees. This creates a powerful win-win situation for the company, its employees, and its stockholders. This relationship is recognized and understood within the private sector, and that is why those who have a quality technical education are doing better than ever before, while those who do not are losing ground. (7)

**AFIT is uniquely situated to
employ its specialized capabilities
to continue its significant role in
providing the intellectual
superiority that will be the key to
a strong competent force able to
successfully meet the challenges
the future holds.**

What role does the Air Force Institute of Technology play in the force multiplier equation for the Air Force? In the areas of logistics, acquisition, and engineering, AFIT has been providing Air Force and Department of Defense (DoD) focused education and research, and producing mission-ready graduates for years. AFIT is uniquely situated to employ its specialized capabilities to continue its significant role in providing the intellectual superiority that will be the key to a strong competent force able to successfully meet the challenges the future holds. Specifically, the graduate programs at AFIT contribute to two of the enabling elements in the force multiplier equation for the Air Force. First, and most obviously, these programs offer the quality education that ensures the intellectual capital needed in tomorrow's Air Force will be available. Significantly, this education is focused through an Air Force and DoD lens, affording the added dividend of mission-ready graduates who are anxious and able to explode out of the starting blocks when they arrive at their next assignment.

AFIT also contributes to the second element of the force multiplier equation—technology. In an obvious way, the Graduate School of Engineering attains this objective through its

Air Force-focused research programs which push the forward edge of technology in certain key areas, as well as classroom education which addresses current technology as it relates to the Air Force and DoD. The Graduate School of Logistics and Acquisition Management does likewise through its focused research on improving the management of a weapon system's life cycle, from system acquisition (including acquisition logistics), to operational logistics support, to research on a discipline which can be referred to as management technology. While physical technology is the realm of Thomas Edison and his laboratory, management technology relates to the management systems, organizational patterns and behavior, processes, and procedures that hold an institution like the Air Force together and permit it to function efficiently or otherwise. If one appreciates that the most important asset of the Air Force is its people, it becomes obvious then that management technology is just as important to mission accomplishment as is physical technology. The Graduate School of Logistics and Acquisition Management creates new and improved management technology through its Air Force- and DoD-focused research programs, as well as transmitting to the future leaders of the Air Force and DoD cutting-edge management technology and practices through the classroom.

It is this leading-edge management technology that makes it possible to exploit physical technology. For example, the Japanese management systems quickly convert worldwide innovation into high-quality industrial and consumer goods at competitive prices, and deliver them to the marketplace on a timely basis. This ability gives the Japanese the illusion of being more innovative on the physical technology frontier than they actually are. However, it is their management technology that enables them to achieve their enviable results. (9)

It is becoming evident that in today's resource constrained environment, the number one enemy of any military system is cost. In the past, the emphasis was placed on effectiveness; whereas today, efficiency shares top billing with effectiveness. This is particularly true in the realm of logistics, where measures of efficiency such as reduced customer wait times, lean infrastructure, and right-sizing the deployment footprint are being emphasized. But it is management technology that in large measure determines efficiency. In all likelihood, cost pressures will elevate the importance of efficiency as serious attempts are made to balance the federal budget. It will be management technology, focused on the unique aspects and requirements of the Air Force, which underpins how successfully the Air Force will execute new initiatives such as Acquisition Reform, Lean Logistics, and focused logistics.

**Some Questions Concerning Graduate Education
for the Air Force**

As noted previously, the Air Force is moving into a future that will be dynamic with evolution and change, and right-sizing, funding availability, privatization, outsourcing, and mission issues will all play roles in this evolution. In light of all this, it is only fair to pose some questions about the graduate education needs of the Air Force in general, and specifically about AFIT's role in meeting these needs. We will discuss these questions below:

Question: What is the overall requirement for graduate education? As we discussed earlier, a smaller Air Force will require a force multiplier to achieve its competitive advantage in much the same way as the US economy, and largely for the same reasons, namely, a highly educated technical force structure. However, in the current downsizing environment, we must be on guard with respect to applying the concept of proportional cuts to education. Under the proportionality argument, since the Air Force has become smaller, the number of advanced academic degree requirements should shrink proportionately. This is a specious argument and, in fact, quite the opposite is the case. Just as a higher proportion of the civilian work force in a high technology, knowledge-based economy needs quality graduate degrees, so do the men and women of tomorrow's Air Force.

This observation applies not to just the select few deemed to be the future leaders who must chart our course, but to personnel at all levels charged with the day-to-day operation of a high tech, high tempo Air Force. The devil is typically in the implementation, and the individuals who do the actual implementing reside throughout all levels of the organization. If key people at all levels lack the appropriate education, poor implementation will frustrate the best laid plans (such as Lean Logistics and focused logistics) every time.

In today's (and tomorrow's) fast-paced, fluid environment, the Air Force will need more people with the skills and tools they accrue from a graduate education. These include not only the technical and informational skills related to one's major course of study, but the analytical, problem solving, and rational thinking abilities one develops as part of a graduate education. These tools are especially important because they can be applied throughout the entirety of a career, and to a broad array of problems and situations. "Education," after all, is what is left over after all the job specific knowledge and skills are removed. A smaller Air Force needs more advanced quality technical degrees because it no longer has large numbers of people, inventory, and an abundance of funds to throw at problems. The remaining folks will have to solve complex problems with brain power. In the absence of a properly educated work force, the Air Force runs the risk of mission failure and/or higher casualties than otherwise would be the case.

Question: Are all graduate degrees equal? Although a rose is a rose is a rose, a degree is not a degree is not a degree. The Air Force Scientific Advisory Board recognizes this reality in New World Vistas, and specifically offers AFIT as an example of a source of Air Force relevant quality graduate technical degrees. (11) Of course there are quality graduate degrees offered by top civilian universities, which are among the best in the world, and many in the Air Force, in fact, are well served by these degrees. Undeniably, though, there are also mediocre colleges and universities offering weak degrees that are convenient and easy to obtain, and inexpensive to boot. As discussed in New World Vistas, the relevance of these degrees is questionable. It is unlikely the Air Force can afford much longer to ignore the quality, content, and relevance of the degrees that its members acquire.

Question: Can AFIT's graduate education programs respond to rapidly changing Air Force needs? In fact, responsive and flexible programs are considered by AFIT to be

one of its core competencies. To date, higher education appears to be the only industry yet to experience an industrial revolution. Most graduate schools still teach the same way that Plato, Socrates, and Aristotle did, but not nearly as well. Not so at AFIT. Since the higher education industry in general has been quite conservative with respect to change, when the dam finally bursts, change will flood the educational landscape. This will play a significant role in the educational process for tomorrow's Air Force. We are already seeing where the increased operational tempo is creating pressures to reduce the amount of full-time effort devoted to education. Commanders want their people available to perform the mission; not out of pocket for long periods of time at school. In the future, students will be less likely to spend as much time in a traditional campus environment than their predecessors did. Educational systems must respond to these changing needs by taking education to the student. Clearly, technology will change the delivery mode of education and training by making distance learning much more practical than it is today, thereby decreasing the time students spend away from their primary duty. Within the Air Force, AFIT is a leader in pioneering distance learning. Literally thousands of professional continuing education students receive instruction this way, as do students of AFIT's graduate mobility program discussed below. It is only prudent for institutions of higher education to begin preparing for the inevitable sea of change in the way education is delivered that technology will bring forth, and for which AFIT is already implementing.

Improvement in the way education is delivered is not the only area where the Air Force's educational needs are changing. As the nature of how the Air Force accomplishes its mission changes, requirements for new areas and subjects for Air Force-focused graduate education will appear, and the graduate education process for the Air Force must respond to these new requirements. It will be of paramount importance that this be done in a timely and responsive manner. Within AFIT, the Graduate School of Logistics and Acquisition Management has recently demonstrated this timely responsiveness by implementing a new graduate program that serves as the prototype for how the changing graduate education needs of the Air Force can be met. This new program, the Master of Air Mobility, was developed for the Air Mobility Command (AMC) in conjunction with the Advanced Studies of Air Mobility program at Fort Dix, New Jersey. The program is presented via a mixed delivery mode. AFIT instructors go to Fort Dix to teach courses there on an accelerated basis, while some courses are taught at the AFIT campus and delivered to the Air Mobility Warfare Center at Fort Dix through satellite hookup. The AFIT library is connected with the Air Mobility Warfare Center as well. This program was initially requested by the Commander of AMC in September 1994, and implemented in full as an accredited master's program in March 1995. As an important side note, every student nominated for the first class by AMC already possessed a master's degree in a different discipline.

Question: Can we rely entirely on civilian institutions? Currently, the majority of the Air Force's budget for military graduate education already is spent at civilian institutions. The civilian institution program is administered by AFIT as well. The Air Force and AFIT for some time have pursued the policy that

whenever a degree requirement falls into the one-size-degree fits-all category, the Air Force officer will be sent to a civilian institution, typically a state university, because the administrators of the civilian institution's program do a fine job negotiating in-state rates at state universities.

There are instances, however, when the procrustean prescription of a generic, one-size-fits-all education does not best serve the needs of the Air Force. In those cases, the two AFIT graduate schools, Engineering, and Logistics and Acquisition Management, offer highly-focused graduate programs that are tailor-made to the needs of the Air Force and DoD. These AFIT graduate schools produce mission ready graduates, focus on Air Force and DoD needs, and are as responsive to Air Force and DoD requirements as an institution of higher learning can be. As previously mentioned, AFIT went from request to implementation of its Master of Air Mobility program in just six months, and this type of responsiveness is not possible from a civilian university.* Many of the courses taught in AFIT's graduate programs have no counterparts in civilian universities. These courses are either unique to AFIT, or are unique because of the specific Air Force and/or DoD focus in the lectures and course material.

At the moment, looking to the best business practices to achieve significant efficiencies within the Air Force is the order of the day. It is the impetus provided by rapid change that is largely responsible for the customization trend. But the desire to align education with the organization's goals, spread organizational culture, and enhance employability of organizational members are factors as well. In many instances, that is the appropriate thing to do. And for the Air Force, it appears to us then that focused graduate education at the Air Force Institute of Technology, not a generic solution, is already the "best of class" as far as educational practices are concerned.

"While there is a premium to be paid to maintain AFIT, the Board of Visitors is unanimous in its belief that there is a richness to the return on investment that cannot be achieved at more traditional civilian educational institutions."

Question: Can the value of an AFIT education be compared to that of a civilian institution? It is extremely difficult to compare the costs and benefits of an AFIT graduate education to that obtained from a state university. There are several reasons why this becomes the classic "apples to oranges"

comparison. First, the costs of an AFIT graduate education in residence are fully allocated, which makes their comparison to the highly subsidized price the Air Force would pay for graduate education at a state university somewhat deceptive. On this basis, a degree from AFIT is more expensive. However, we must appreciate that any organization (including the Air Force) would have to pay a premium (or provide a subsidy) to a civilian institution in return for receiving the same responsiveness, attention, and focused education that AFIT currently provides. Additionally, the value of mission-oriented, Air Force- and DoD-focused research must be considered. Over 90% of AFIT's thesis research is sponsored by external Air Force and DoD organizations. As noted earlier, this research helps solve some of the key technology problems faced by the Air Force as it moves into the next century. AFIT's research sponsors have recently estimated that the value of the research they receive is about \$30 million per annum. And fully 80% responded that they would have funded this research from other sources had it not been supplied by the AFIT graduate schools. The latest (1996) AFIT Board of Visitors (BOV) looked at the value of AFIT graduate education in comparison with that from civilian universities. The BOV concluded, in fact, that the investment the Air Force makes in graduate education at AFIT provides an impressive return on investment in terms of mission-ready graduates, as well as focused and responsive research and consultancy. The BOV report states, "AFIT provides an array of values that benefit its students, the Air Force and, ultimately, the entire nation." The report concludes by saying, "While there is a premium to be paid to maintain AFIT, the Board of Visitors is unanimous in its belief that there is a richness to the return on investment that cannot be achieved at more traditional civilian educational institutions." (13)

Could the graduate education provided by AFIT be completely civilianized? The answer is yes, but at what cost? As in all areas, there are trade-offs that must be assessed. For a civilian university to produce mission-ready graduates, produce high quality Air Force-focused education and research, and provide the responsiveness currently offered by AFIT, the Air Force will need to send many students to a single institution, and guarantee a steady stream of students for a lengthy period of time. Probably a check, in addition to in-state tuition, will also have to accompany the students. Otherwise, it does not pay a civilian university to change their existing one-size-fits-all degree.* Also, the time for these schools to acquire faculty who can provide relevant Air Force perspective to the course materials must also be considered. And, perhaps, the ultimate trade-off to be considered is strictly cost versus value. This is, namely, the loss of all the value currently provided by AFIT versus the money saved (estimated to be about \$13 million per year) by using generic (and fully subsidized) civilian university degree programs. Ultimately, all these trade-offs must be measured against the benchmark of Air Force doctrine and the quality of education in the force multiplier equation discussed earlier.

(Continued on page 36)

* Typically, it takes two years or more for a new program to be debated and approved by all the curriculum committees, the faculty senate, and for public universities, the Board of Regents or the Department of Education.

* Given the fixed assets associated with launching a new program, before a civilian university would consider such a decision, it would require a guarantee of a sizable number of students for an extended period of time.



CAREER AND PERSONNEL INFORMATION

Logistics Professional Development

Community College of the Air Force Logistics Degree Program

When most people talk about logistics education in the Air Force, the emphasis is often focused on officer education programs such as those at the Air Force Institute of Technology (AFIT). AFIT's quality degree programs in the different fields of logistics are widely known and well respected throughout the civilian and military communities. Lesser known and sometimes overlooked, however, is the Air Force's other logistics degree program, offered by the Community College of the Air Force.

The Community College of the Air Force (CCAF) was founded in 1972 with a charter to provide occupational-related credentialing programs to the Air Force's enlisted corps. In 1980, the college became regionally accredited by the Southern Association of Colleges and Schools/Commission on Colleges and began awarding the Associate in Applied Science (AAS) degree that same year.

As one of CCAF's 68 AAS degree programs, the logistics degree program provides a valuable educational credential for Air Force enlisted people in the supply, logistics plans, medical supply, and fuels career fields. Other fields traditionally considered as logistics related, such as transportation, contracting, and maintenance have their own separate degree programs.

The logistics program provides those members in the above mentioned career fields an avenue to pursue a formal technically-oriented field of study in their primary Air Force Specialty Code (AFSC) which can enhance their knowledge, training, experience, and value to that career field. This program of study produces noncommissioned officers (NCOs) and airmen who are generally more technically qualified in their respective AFSCs, improving their mission readiness capability for the Air Force.

The logistics program, like all of CCAF's degree programs, requires a total of 64 semester hours of collegiate-level credit distributed among the areas of general education, leadership, management, and military studies (LMMS), program electives, and technical education. Of those 64 semester hours, 16 must be CCAF residency credit (earned from a CCAF affiliated school, such as technical training, professional military education (PME), etc.).

Since the LMMS, general education, and program elective requirements are essentially the same for all current CCAF degree programs, the technical education area is really what distinguishes the logistics degree from all the others. While all CCAF degrees require 24 semester hours of technical credit, the requirements

for the logistics program are specifically designed to meet the needs of those students in the supply, fuels, logistics plans, and medical supply career fields.

The technical education component of the degree is very similar to the concept of an academic major found at other colleges. Like other majors, it is comprised of required subjects and electives. Of the 24 semester hours required for the technical area, at least 12 must be required or core subjects, such as Logistics Management, Inventory Management, Fuels Accounting/Management, Accounting, and so forth. A student usually obtains the credit for these areas by completing a resident Air Force skill-level awarding course or follow-on course. However some credit, such as accounting, can come from courses taken at other institutions.

A maximum of 12 semester hours of credit can be applied to the elective portion of the technical area. It usually comes from a variety of sources to include Air Force technical schools, enlisted PME, and civilian college courses. Some typical titles for technical electives include: Computer Science, Business Mathematics/Statistics, Introduction to Business, and Marketing, to name a few. These course titles are excerpts from the CCAF 96/98 Logistics Program. Students should check the catalog year they are enrolled in for specific degree requirements.

Many people, including students, supervisors, commanders, and even other logisticians question the value of a two-year logistics degree. Its value in the military arena may be more self-evident; enlisted people with a college degree enjoy greater assignment flexibility, opportunities for increased responsibility, and a considerably better chance at promotions. For example, 49% of those eligible for promotion to senior master sergeant in 1996 had CCAF degrees. But 82% of the total selected were CCAF graduates. The value of a two-year degree in the civilian logistics community may be some what less visible, but equally as important. Employers generally favor a skilled worker with a technical degree more than a skilled worker with a general educational background or an unskilled worker.

While all Air Force enlisted members are now automatically enrolled in a CCAF degree program based upon their AFSC, active participation in the degree program is purely voluntary. Supervisors and commanders at all levels can do much to widen this avenue of professional development to NCOs and airmen by encouraging off-duty education, formal Air Force training, and PME attendance. The small investment of time, dedication, and brain cells bring back a wealth of return for not only the individual, but also for the Air Force!

For more information on pursuing a CCAF degree, contact your local education office, or CCAF at DSN 493-6447.

(TSgt Bobby Rogers, CCAF/DFAS, DSN 493-6447)

Logistics Career Broadening Program

Interested in logistics cross flow, or a challenging assignment at an Air Logistics Center (ALC)? The USAF Logistics Career Broadening Program (LCBP) is continually seeking outstanding officers looking for opportunities in the logistics environment. The LCBP is a Deputy Chief of Staff, Installations and Logistics (HQ USAF/IL) sponsored program at Air Force Materiel Command (AFMC), specializing in acquisition logistics and life cycle sustainment support. Air Force Instruction (AFI) 36-2111, *The Air Force Logistics Career Broadening Program*, contains specific guidance. The program provides participating officers experience in managing the acquisition and wholesale aspects of the Air Force logistics system. This is a three-year controlled tour where officers rotate every four to six months to different ALC directorates during the first two years (Phase I), and then work in an ALC authorization for the last year (Phase II). There are currently 68 authorizations which are equitably distributed throughout the five ALCs. All positions are acquisition coded to facilitate Acquisition Professional Development Program (APDP) Level I certification for the LCBP officers.

This program applies to officers with the Air Force Specialty Code (AFSC) of 21XX, 33SX, 63AX, 64PX, or 65FX. Officers selected must be in the grade of captain with at least 5 years and no more than 12 years Total Active Federal Commissioned Service (TAFCS). Officers must also possess the fully qualified AFSC for the position for which they are to be considered, and be eligible for permanent change of station (PCS) under the officer assignment system guidelines.

AFMC continually advertises through the Electronic Bulletin Board (EBB) projected LCBP vacancies, and HQ AFMC/DPAO maintains a long-range forecast of projected vacancies. Officers volunteer for the EBB ad of their choice with Headquarters Air Force Personnel Center (HQ AFPC). Once the EBB closes out, HQ AFPC provides a list of qualified volunteers to HQ AFMC/DPAO along with the officer's last five officer performance reports (OPRs). The appropriate HQ AFMC functional staff makes the selection, and HQ AFPC processes the assignment.

Upon completion of Phase I, HQ AFPC awards the special experience identifier (SEI) LLA which remains a permanent part of the personnel data system. The SEI is used for tracking purposes as required. In addition, in 1995, HQ USAF/LG announced that LCBP officers awarded the SEI LLA will gain credit for logistics cross flow.

For further information please contact Capt David Haar, DSN 787-2125, Fax DSN 787-5345, or e-mail: haardm@wpgate1.wpafb.af.mil. LCBP information can also be located on the World Wide Web at <http://www.afmc.wpafb.af.mil/organizations/HQ-AFMC/DP/dpa/broad.htm>. The World Wide Web provides a great deal of information and will answer most questions you may have.

(Capt David Haar, HQ AFMC/DPAO, DSN 787-2125)

Your Logistics Assignment: It Is *Your* Move

Greetings from the Logistics Officers Assignment Branch at the Air Force Personnel Center (AFPC) at Randolph AFB, Texas. Since my arrival at AFPC, I have learned a few things about the assignments process as it relates to the world of logistics. I would

like to share some of these facts so you will better understand the assignments process and be able to enhance your career as a loggie.

When was the last time you discussed with your squadron commander, group commander, or division chief, your next permanent change of station (PCS) move desires? Have you waited too long to discuss your options with your AFPC career field functional representative? Whether you are a lieutenant or a lieutenant colonel, it is to your advantage to make the initial input into your next assignments action. It is never too early; self-education is the key.

The current assignments system is geared around moving the logistic officer at the 3-year time-on-station (TOS) point for CONUS-to-CONUS moves. Officers should begin reviewing job opportunities nine months prior to their three-year TOS month by using either the Electronic Bulletin Board (EBB), or the "Assignments On Line" feature of the AFPC Home Page on the World Wide Web (<http://www.afpc.af.mil>). After finding those advertised jobs that will move you at the three-year TOS point, talk with your commander to discuss your professional development, job choice, and releasability from your current duties. Once you have done this, volunteer for jobs on-line, or give your AFPC functional representative a call before the ad's "Need volunteer by:" date. This date represents the date the ad will close for advertising. Volunteers cannot be accepted past this date.

In June 1996, the Personnel Center started using a new system to select officers for assignment. It is called, "More Choice, More Voice." AFPC no longer selects the "#1 best-matched officer" for the assignment (with the exception of joint duty positions). Instead, we compile a list of eligible, qualified volunteers for the job—up to ten—and forward that list to the gaining commander or hiring authority for selection. This new process gives the gaining commander "more choice" in who to hire. The officer volunteering for the job, the officer's commanders, and AFPC all provide the "more voice" portion. How does it all come together?

In a nutshell, here is how it works. Once the ad closes for a particular job, the AFPC assignment action officer who owns the ad racks and stacks the eligible qualified volunteers according to their priority of move status. This prioritized list is then sent to the hiring authority to make the selection. The five categories of priority on the list are (from highest to lowest priority):

- (1) Overseas short tour returnees.
- (2) Overseas long tour returnees.
- (3) Base closure/unit deactivation.
- (4) CONUS maximum tour completion.
- (5) All others.

Categories 1 through 4 represent officers with a DEROS (Date Eligible to Return from Overseas) or pre-approved assignment availability code which identifies them as mandatory must movers. The hiring authority for a certain job must give priority consideration to the officer in the highest must move category, or submit written justification to AFPC of why a must mover in a higher category is not qualified to hold the job. After the hiring authority tells AFPC who they want to hire, the assignments action officer performs a quality check in the form of Losing Commander's Involvement Process (LCIP). Once positive LCIP

is received from the officer's commander, then the action officer can continue the assignment processing. If there are no other assignment limitations, then the action officer can write the assignment and send an assignment notification message to the officer's Military Personnel Flight (MPF) within a week. The local MPF will cut the appropriate PCS orders.

In a perfect world, all ads would receive multiple volunteers. In the case of an ad that does not receive any eligible qualified volunteers, it is AFPC's duty to select a qualified officer to fill the valid requirement of the ad by the Report Not Later Than Date (RNLTD). We source an officer by using one of the three assignment selection rosters, depending on what type of job we are filling:

- Short tour roster.
- Long tour roster.
- Time-on-station roster (for CONUS jobs).

The month and year of vulnerability for each of these rosters for a particular Air Force Specialty Code (AFSC) can be found on the EBB or "Assignments On Line." You should know where you stand on these rosters, based upon the number of short tours you have done, your Overseas Duty Selection Date (ODSD), and your time on station.

Knowing where to find jobs that pertain to you is very important; do not miss an opportunity because you could not find it advertised. Keep in mind while "surfing the web" or EBB for potential jobs that all ads may not be listed under your specific career field AFSC. For example, lieutenant colonel logistician jobs may be listed under AFSC 21LX or 20C0. Also, career broadening opportunities such as Reserve Officer Training Corps (ROTC) instructors, Officer Training School (OTS) and Squadron Officer School (SOS) flight commanders, and recruiting jobs are usually listed under different AFSC's, and may require that you search a different area in the want ads.

All valid vacancies are advertised on the EBB or AFPC Home Page. Direct hire jobs are the only exception; however, they can be advertised at the request of the hiring authority and major command. Examples of direct hire jobs are squadron commander and deputy logistics commander jobs. Advertised jobs include CONUS, overseas, and joint duty jobs. Career enhancing opportunities such as the Air Force Institute of Technology Masters Degree Programs and the Logistics Career Broadening Program (LCBP) are advertised as ads on the bulletin board.

You are the catalyst behind your next PCS career move. Get started early and keep your commander and AFPC in the loop of information. Feel free to contact your AFPC assignments action officer by phone, voice mail, email, or fax (DSN 487-3408) for assistance. Good luck with your next assignment!

Logistics Officer Assignment Branch Points of Contact

Branch Chief

Maj Ed Hayman, DSN 487-3556, haymane@hq.afpc.af.mil

Transportation Officer Assignments

Capt Tom Jett, DSN 487-4024, jett@hq.afpc.af.mil

Capt Ken Backes, DSN 487-4024, backesk@hq.afpc.af.mil

Supply Officer Assignments

Capt Craig Bond, DSN 487-6417, bondc@hq.afpc.af.mil

Capt Debbie Elliot, DSN 487-6417, elliotd@hq.afpc.af.mil

Logistics Plans Officer Assignments

Capt Rick Cornelio, DSN 487-5788, cornelir@hq.afpc.af.mil

Capt Keith Quinton, DSN 487-5788, quintonk@hq.afpc.af.mil

Aircraft Maintenance Officer Assignments

Capt Marc Novak, DSN 487-3556, novakm@hq.afpc.af.mil

Capt Ray Roessler, DSN 487-3556, roessler@hq.afpc.af.mil

Capt Wes Norris, DSN 487-3556, norrisw@hq.afpc.af.mil

(Capt Ray Roessler, HQ AFPC/DPASL, DSN 487-3556)



The AFPC Logistics Officer Assignments Team: (Front Row, Kneeling, Left To Right, Capt Ray Roessler, Capt Tom Jett, Maj Ed Hayman; (Middle Row, Kneeling, Left To Right), Capt (Maj Select) Rick Cornelio, Capt Ken Backes; (Back Row, Standing, Left to Right) Major Craig Bond, Capt Keith Quinton, Capt Debbie Elliot, Capt Marc Novak, and Capt Wes Norris.

Civilian Career Management

Logistics Civilian Career Broadening Program

The Logistics Civilian Career Enhancement Program (LCCEP) manages 35 career broadening positions, grades 12, 13, and 14, which provide a two-year assignment at the Office of the Deputy Chief of Staff, Installations and Logistics (HQ USAF/IL) and at the major commands, including Headquarters United States Air Forces in Europe (HQ USAFE) and Headquarters Pacific Air Forces (HQ PACAF). Career program registrants selected for the program have an opportunity to broaden their logistics experience through the accomplishment of work assignments which provide individual development in logistics plans and programs. The majority of the positions are in the Pentagon, however other locations include: Langley AFB,

(Continued on bottom of page 41)

Logistics Lessons From the Past—Deployed Operations

Group Captain Peter J. Dye, RAF

"Wot makes the soldier's 'eart to penk, wot makes 'im to perspire?
It isn't standin' up to charge nor lyin' down to fire;
But it's everlastin' waitin' on a everlastin' road
For the commissariat camel an' is commissariat load..."

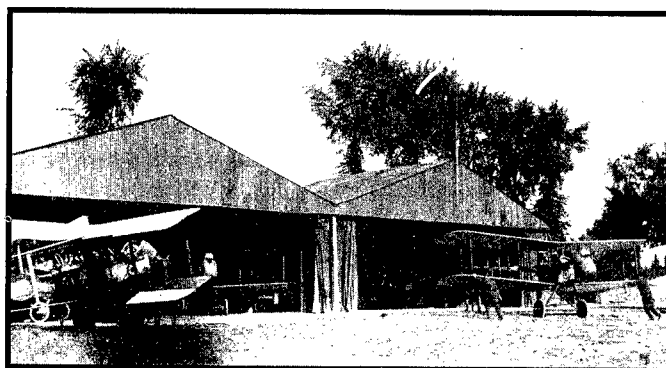
Northern India Transport Train—Barrack-Room Ballads. Rudyard Kipling.

Logistics is not so much a science as an art, and yet, under the pressure of tighter budgets and downsizing, there is great temptation to adopt the view that sophisticated resource modeling and realistic simulation (including wargaming), together with careful staff work, are sufficient in themselves to provide for effective support of deployed operations. But anyone who has had to maintain aircraft or other complex weapons systems, whether at home or overseas, will know how the unexpected can rapidly degrade effectiveness, notwithstanding the resources available, or the depth and detail of the advance planning.

I am not suggesting we cannot continue to use the techniques mentioned above (and others) to control costs and improve our logistics support. However, much of our recent experience relates to a scenario that increasingly appears to have been driven by an exceptional period in world affairs. Whether we like it or not, our current methods of doing business largely reflect the lessons learned in the Cold War and are tailored to supporting the main base concept. Of course, we cannot simply abandon tried and tested procedures, but we are entering a period of radical change and a concept of operations that owes more to the Royal Air Force's (RAF's) experience up to 1945 than the subsequent 50 years of "peace." Recent studies have addressed the RAF's conceptual framework for developing its capabilities to deal with new realities. Nevertheless, it is very much new territory, with few examples and little practical experience to draw upon. That being so, I would suggest there is considerable merit in looking at how the RAF supported deployed operations in the first half of this century, as part of the on going process to develop our post-Cold War logistics strategy.

In case there are those who suspect my thesis implies things were done better in the past—that there was a sort of logistics golden age—I would mention the deployment in 1916 of the Number 29 Squadron to join the Expeditionary Force. Number 29 Squadron had been formed at Gosport from the Number 23 Squadron in November 1915. Towards the end of January 1916, 20 DH2 Scouts were allotted to the new squadron. It was decided (somewhat rashly as events proved) to deploy the ground crew and support personnel, together with the squadron transport, ahead of the aircraft move. The former proceeded overseas on 14 March. Ten days later, the aircraft set off for Dover, but mechanical problems (exacerbated by inexperience with the new aircraft, the fact that the squadron had been largely without ground crew for nearly two weeks, whilst most of those

remaining had contacted measles), poor weather, and accidents en route meant that by the second week of April only 12 machines had actually reached France. The overall attrition was even worse than one might suppose, since the original allocation of 20 aircraft had been supplemented by further deliveries direct from the manufacturer (but none with compasses fitted, which raised some concerns amongst those pilots, who had managed to reach Dover, as to the wisdom of a Channel crossing). Headquarters Royal Flying Corps (HQ RFC) subsequently calculated that, "the total number of machines consumed, in order to deliver at St. Omer 12 serviceable, was 27." (1) The majority of these were scattered around Southern England, some written-off, whilst others ditched in the Channel or crashed on landing in France. The pilots involved fared little better, suffering their fair share of injuries, as well as measles, such that the last arrived in France over two weeks later. All in all, it was not one of the RFC's finest hours.



DH2s from the Number 29 Squadron—Abeele, Belgium, 1916

Whilst this catalogue of disasters may be entertaining at this distance, I doubt there are any fundamental lessons to be learnt. However, there are aspects of RAF deployed operations in the Second World War that are actually quite instructive. (3) One example is the logistic support for the RAF elements involved in Operation TORCH, the North African landings that took place in December 1942. Some 450 aircraft were involved in the Eastern operation, centred on Algiers, tasked with providing air cover for the shipping and ground forces, and, once ashore, to protect against air attack and to support the subsequent land advance. Immense difficulties were encountered as this was the first large-scale amphibious landing to be undertaken by the Allies. It was also the first real test of Anglo-American cooperation, the conduct of joint operations and, most importantly, of joint planning. As far as the air element was concerned, it was agreed that the Army would provide fuel and weapons, whilst the RAF would furnish all support vehicles, ground equipment, and technical stores. The relevant equipment was packed at maintenance units in the United Kingdom (UK)

to schedules prepared by the Air Ministry, but the sponsoring branches had no visibility of what was actually provided. It was subsequently reported by the units making up the packs that there were 72% inabilities. All "pack-ups" were allocated, in the interests of security, field unit serial numbers. The code for these numbers was given a very limited distribution and not included in the administrative instructions. All stores were then loaded at UK ports for travel by convoy directly to join the Eastern Task Force at Gibraltar.

The actual landings met little opposition and the advance RAF ground parties were able to reach their designated airfields and receive the first Allied aircraft by 1030 on the morning of D Day. Thereafter matters got more difficult. Enemy air attacks commenced in earnest, fuel was in extremely short supply, and essential equipment either did not arrive at the beachhead or was lost on landing (this problem was exacerbated by the limited attention that had been paid to the loading of the ships in the UK such that in some cases it took two days to unload priority equipment). It would be wrong to suggest the planners had not anticipated the difficulties likely to be faced in landing large quantities of stores across open beaches, since it had always been intended to bring the bulk of the equipment, needed to support the subsequent land and air operations, through the port of Algiers. But, not unexpectedly, given the immense amount of materiel to be unloaded, the docks were rapidly saturated. More significantly, however, the RAF embarkation staff of 26 personnel of all ranks was quite incapable of sorting the mountains of equipment being discharged. The result was not only were the docks swamped with piles of stores which in fact would not be needed for many weeks, but there was also no means of distinguishing between cases. A great deal of unnecessary equipment found its way to the forward areas in place of items that were urgently required. To make matters worse, although the consumption of ordnance was far less than had been anticipated, the early consignments of bombs arrived with the wrong components or without components at all; this included fusing links. By the end of January the process of marrying up bombs with tails had still not been completed satisfactorily (without wishing to exaggerate, there are echoes of our own experience during Operation GRANBY). There was also the usual share of unexpected, and hence unplanned, maintenance problems. For example, the soft state of the airfields following heavy rain resulted in a large number of aircraft ground looping and breaking their propellers, therefore stocks were rapidly exhausted.

Logistic problems did not end here. The numbers of RAF movements staff were totally inadequate to the task and thus had to rely upon Army movements personnel. But without the key to unit serial numbers, the latter could only surmise for whom the equipment was intended. This generally ended in it being sent to the wrong unit, who, knowing only its own serial number, could not dispose of the equipment to its proper destination. As a result, much of the equipment off-loaded from the first convoy into Algiers did not reach the correct units until many weeks had elapsed. Finally, when the pack-ups were opened it was often found the items required were either missing or present only in reduced quantities.

Those involved in the handling of stores at Al Jubayl during Operation GRANBY nearly 50 years later may have noticed

some similarities between their experiences and the problems encountered in Operation TORCH. In neither event was there effective enemy action to interrupt the supply chain and yet immense difficulties were encountered simply as a result of the scale and pace of the buildup, the sheer volume of stores, and the almost impossible task of locating specific equipment amongst the countless crates and International Standards Organization (ISO) containers on the dockside. One is forced to conclude that moving thousands of tons of stores across a continent has always been the simplest (but not necessarily the easiest) part of any logistic operation. My personal experience during Operation GRANBY would suggest, however, that even this statement has to be qualified. I recall on one occasion a serviceable aeroengine, urgently required at Muharraq, returning from Lyneham on the same lorry that had rushed it down there—much to the distress of the driver. More importantly, the original inbound unserviceable engine was at that very moment winging its way back to the Gulf in the back of a Hercules! To be blunt, delivering the required item, to the right hands, at the right place, and at the right time, remains the overriding challenge for any logistic organization. It is also true that forging the last link in the support chain can be as difficult as assembling the remainder. It is a task made all the more challenging in a joint multinational environment, subject to the vagaries of host-nation support and the inevitability of unplanned (and hence inadequately provisioned) unserviceabilities. The way ahead must surely lie in both improving asset tracking and also providing greater visibility of the supply chain to all parties, including the consumer as well as the supplier.

One of the unique aspects of the RAF's logistic planning for Operation TORCH was the creation and employment of servicing commandos. These units comprised up to 150 RAF tradesmen, with intensive combat training, who were to be landed during the assault phase and would be capable of defending themselves (and their aircraft), whilst also undertaking the daily servicing, refueling, and rearming of aircraft operating from advance landing grounds and captured airfields until such time as the main squadron servicing parties arrived. In theory, the servicing commandos—although entirely comprised of Trade Group 1 (technical) personnel—could only provide rudimentary support as their tools and equipment would be necessarily limited. However, the servicing commandos employed during Operation TORCH had to undertake the maintenance of many more squadrons, of several aircraft types, and for a considerably longer period than originally intended, owing to the difficulties outlined above as well as problems in assembling and moving the appropriate technical personnel forward. In fact, instead of being relieved after a few days, they were employed continuously for five weeks without rest. (2)

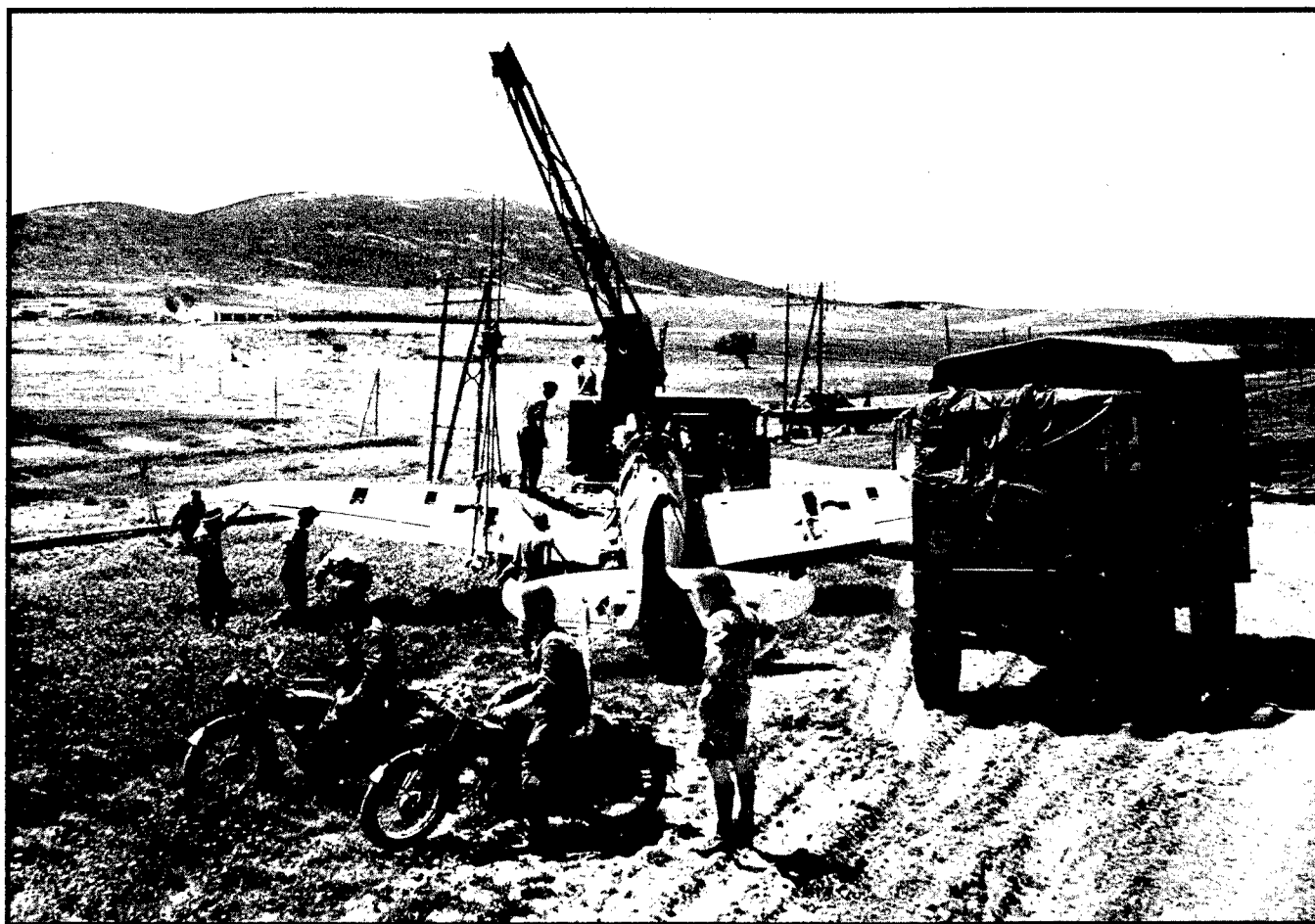
Notwithstanding the servicing commandos' efforts, the lack of maintenance facilities and skilled personnel soon began to make itself felt in the form of reduced aircraft serviceability. This is not to say the logistic planning had failed to make provision for the sustained support of aircraft operations, but it had been envisaged that the majority of squadrons once ashore would be rapidly joined by their assigned maintenance personnel, as well as air stores parks (with sufficient equipment to support 30 days of maintenance) and repair and salvage units. Quite deliberately there had been no provision for major repair (beyond what the

repair and salvage units could undertake) in the anticipation of a relatively brief campaign. In the event, the operational commanders decided to accelerate the aircraft deployment plan and this, coupled with the supply chain difficulties already outlined, meant squadrons were compelled to operate for some time without support equipment, adequate servicing and repair arrangements, or even transport and signals support. Typical of these difficulties was the plight of the two Beaufighter night fighter squadrons called forward three weeks early. On arrival they had to be maintained by members of the aircrew, co-opted ground personnel from a collocated Hudson squadron, and mechanics from a repair and salvage unit. To compound these problems, the Beaufighters' radar equipment had been removed for security reasons and sent by sea with the ground personnel. Therefore, an emergency supply of radar equipment had to be flown out direct from the UK before night fighter operations could commence. But, not surprisingly, the hastily assembled maintenance team found the radar extremely difficult to install without any specialist knowledge or the appropriate support equipment and tools.

Eventually, the 2nd Line maintenance units were able to come into action, but this did not immediately resolve every problem. The repair and salvage units found they faced an immense backlog of repairs because of the delays and were effectively immobilized whilst the stores parks discovered the storage space provided by the Army was but a fraction of their actual

requirements. Eventually some additional space was found in local farm buildings. Strenuous efforts were made to recover this situation as the campaign developed by improving both the support arrangements as well as the mobility of the squadrons. Maintenance personnel in the forward area were reduced to a minimum to enable the squadrons to be placed on a mobile basis capable of movement at short notice utilizing their own motor transport. The remaining maintenance personnel were withdrawn to the rear echelons. The forward stores parks were also reduced to "immediate issue" stocks only (and the personnel reduced accordingly), whilst the repair and salvage units were totally withdrawn, other than small mobile sections to work with the squadrons. In general, these new arrangements worked well and would provide the pattern for all subsequent campaigns.

Amongst the many other lessons learnt from Operation TORCH was the need to schedule carefully the arrival of equipment and stores, whilst ensuring the necessary personnel and repair facilities were in place as early as possible to permit effective air operations. That said, it was also clear too large a forward support organization would take a disproportionate share of the available shipping and assault craft, whilst also serving to hinder subsequent mobility. Exercises undertaken in the UK during 1943, in preparation for the Normandy landings, confirmed the overriding importance of reducing what might today be referred to as the "deployment footprint." In fact, how best to organize the maintenance support for squadrons whilst



A Repair and Salvage Unit Recovering a Spitfire—Tripolitania, 1943

enhancing their mobility, was a question which Group and Command staffs had been struggling with since 1940. Prior to the expansion of the RAF, fighter squadrons were largely self-sufficient, each flight having the capability to undertake in-depth repair, as well as the normal servicing functions. It was soon evident this system could not cope with the increased flying rate and greater technical complexity that accompanied the expansion programme. As a result, maintenance support was reorganized on a squadron basis; two flights being responsible for servicing tasks, whilst the third flight undertook major repair work and the deeper inspections. This system, which today we would probably describe as an "autonomous" maintenance organization, remained in force for the first year of the war. However, during the Battle of Britain it was discovered that the mobility of squadrons was adversely affected and the frequent squadron moves resulted in the maintenance personnel being increasingly detached from their units, sometimes being spread over at least three different stations.



Squadron Engineering Personnel Repairing A Hurricane—Battle of Britain, 1940

In an endeavor to improve the mobility of the squadrons and avoid the need to transport large ground parties and redundant bulky equipment from station to station, it was decided to reexamine the maintenance system. After toying with a proposal to do away with all maintenance personnel and rely entirely upon station support (the "centralized" approach), it was agreed a "semiautonomous" organization should be adopted, whereby the bulk of the repair responsibility, associated tradesmen, and ground equipment would be transferred to the station "maintenance party," leaving only sufficient squadron maintenance personnel to conduct daily servicing and minor inspection tasks. The squadron engineer officer would remain in the squadron but the station maintenance party would provide echelons attached to each squadron, albeit under the command of the station engineer officer. These echelons could also provide a mobile unit to accompany the squadron for "bare-base" moves.

Over the next few years this organization was further developed to become almost fully centralized; the supporting technical personnel were in effect entirely divorced from the flying squadrons. A three-tier structure was introduced

comprising: (1) the "Advanced Landing Ground," where quick turnaround servicing would be carried out by servicing commandos (as already described); (2) the "Airfield Area," capable of supporting three squadrons where servicing was fully centralized under the station maintenance party; and (3) the "Base Area" that undertook maintenance beyond the station maintenance party's capability or capacity to complete in under 48 hours. The Airfield Area was in essence a mobile station, but to achieve this it was necessary to create additional support units, including repair and salvage units, and forward stores parks. This system was extremely successful in providing effective support to the RAF's flying squadrons, both through the North African and Italian campaigns as well as during and after the Normandy landings. It should be noted that, notwithstanding the centralized maintenance organization, particular efforts were made to sustain squadron identity by affiliating Airfield Area echelons to specific squadrons under a squadron technical officer. This also served to improve the welfare and management of the technical personnel concerned. That said, such pragmatism was not allowed to detract from the overall policy of centralization.



1000 Pound Bombs Alongside an RAF Mustang—Normandy, 1944

As a footnote, the sort of problems experienced by the Number 29 Squadron in 1916 were resolved by making temporary provision at the base airfields in Southern England for maintenance support, while the squadron servicing personnel established themselves in Normandy. In the event, the maintenance arrangements worked extremely well. The first servicing commandos landed on D + 1 and received their initial aircraft on D + 2 (on a temporary basis, for refueling and rearming). By the afternoon of D + 3 some 3,500 RAF personnel and 815 vehicles had been landed. The permanent move of fighter squadrons to airfields in Normandy commenced on D + 4, once the Airfield Areas were ready to receive them. Thereafter the pace of deployment accelerated such that, by the end of June, one wing was arriving every five days. Once again, the servicing commandos had proved invaluable, not only enabling damaged

aircraft to return back to base, but also ensuring an extremely high availability rate. Nevertheless, once the bridgehead was established and the Airfield Areas in theatre, their importance rapidly declined and they were withdrawn at the end of July.

As in Operation TORCH, a number of environmental maintenance problems arose. Rather than wet airfields, the cause in this instance was dust. The soil on which the landing grounds were constructed contained a very high proportion of silica which lessened the life of engines, particularly those not fitted with air-cleaning devices (such as the Typhoon's Sabre). Unserviceabilities rapidly rose and it was only by pumping oil and water onto the airfield surface and minimizing warm-up times that the problem could be contained (but not before 66 engines had been damaged beyond repair). There are echoes again here of the RAF's experience in Operation GRANBY. I would only add that maintaining sophisticated aircraft and weapons systems outside of their normal operating environment is something that has to be practiced. Careful planning, experience, and foresight are not a substitute for the real thing!

Following the Normandy breakout, the primary problem facing the maintenance organization was the ever lengthening lines of supply. Transport aircraft were used to supplement the supply chain and, in particular, to deliver aviation fuel to help support the momentum of the advance. This was successful, and at no stage were operational units ever prevented from carrying out sorties for lack of supplies. In order to avoid bottlenecks and

minimize forward storage requirements, the provisioning system was based upon a "call-forward" principle, rather than the base organization sending supplies into the theatre at will. This has clear parallels to today's concept of "just-in-time" supply and express chain management.

Turning to the lessons we might draw today, I would first observe that the RAF's organizational structure to support deployed and mobile aircraft operations in the Second World War took some four years to perfect. The result was a lean, efficient system that: sustained high availability; enhanced squadron mobility, flexibility, and economy in manpower and equipment; and enabled squadron commanders and airmen to concentrate on their operational responsibilities. (4) It may well be the servicing commando concept—given the remote possibility we will again be required to participate in an amphibious assault on a hostile shore—will remain simply an historical curiosity. Nevertheless, and notwithstanding the passage of time and subsequent technological development, the lessons of 1939-45 provide much food for thought in deciding how best to develop logistics support. Do we really have the right maintenance organization to cope with the post-Cold War era? To date, studies have focussed largely on the mechanics of deployment support and the resourcing implications rather than the organizational aspects and how this might be developed to enhance mobility and reduce the forward support requirements, particularly the deployment footprint. I have always been an enthusiastic proponent of the



RAF Servicing Commando Personnel "Bombing-Up" a Spitfire at an Advanced Landing Ground—Normandy, 1944

semiautonomous maintenance organization, believing the enhanced squadron "esprit de corps" brings very real benefits. But, this should not blind us to the very real issue of whether such a system is the best or indeed the only way to support deployed operations in the future. Is there not a very real danger that we are solving tomorrow's problems with today's solutions? At the very least the question should be debated.

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(Continued from page 27)

Summary

Granada, Panama, Somalia, the Persian Gulf War, and Bosnia were logistical nightmares. In the Gulf War, critical lift assets were tied up and far more assets were shipped to the theater than were really needed. A lot of this was a function of not knowing what was in the containers or being able to track parts and equipment. (2,12) While it is true that in the future, many traditionally military logistics functions will be privatized, frontline or battlefield logistics, and the interface with, and operation of, rear echelon logistics will still be of paramount importance in determining the success or failure of an operation. To avoid such difficulties in the future, the DoD and the Air Force must produce not only the strategic thinkers in this critical arena who continuously improve existing management technology as well as add to the extant storehouse, but those who are able to implement these "best laid plans." And, in an era of ever-shrinking budget authority, the success of force modernization will depend on those who can master the complexity and fluidity of the rapidly changing and unique military technological and acquisition environment. Given the differences between civilian and military logistics and acquisition, and the emphasis on efficiency as well as effectiveness, the focused, responsive, and quality graduate education provided by AFIT guarantees the Air Force and the DoD will receive a constant stream of officers and government civilians armed with the strategic mental acuity to solve some of the Air Force's most vexing problems in the future.

With the disintegration of the Soviet empire, no nation can compete with the US across the board as far as physical technology is concerned. It is imperative that such is also the case vis-à-vis management technology, for without it, it is not possible to exploit the full range of physical technologies that a nation possesses. Most would agree that institutions and organizations vested with public interest should be directed by doctrine rather than personality or financial expediency. The evolution of man has taken such a path that it is now the size of a man's brain that constitutes the competitive edge—not the size of the club that the man wields. But this brain must be honed through appropriate education and training. Now, more than ever, the vital education element of the force multiplier equation must continue to be incorporated as a fundamental tenet of Air Force doctrine. The consequences of not doing it may very well be unacceptable.

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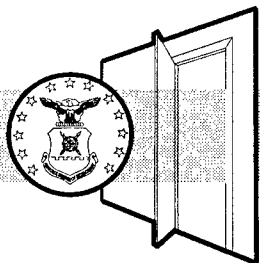
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Student research is a key component of the Air Force Institute of Technology's Graduate School of Logistics and Acquisition Management programs. All students, working either alone or in teams of two, complete a master's thesis. Many of the thesis research efforts are sponsored by agencies throughout the Department of Defense. This issue highlights the superior thesis research efforts produced by the class which graduated September 1996. A copy of each thesis is available through the Defense Technical Information Center (DTIC), Cameron Station, Alexandria VA 22304-6145, DSN 284-7633.

AFIT Commandant's Award (Most exceptional research contribution to the student's field)

Title: *Does a Rubber Baseline Guarantee Overruns?* (A Study of Cost Performance and Contract Changes in Major Defense Acquisition Programs)

Author: Captain James A. Gordon (AFIT/GSM/LAS/96S-5)

Advisors: Dr. Dave S. Christensen (LAS) and Richard Antolini (LSQ)

Sponsor: Office of the Under Secretary of Defense (Acquisition), Washington DC 20301-3020

This thesis explores the assumption cost overruns are related to contract changes. A common assertion in defense literature says contracts which are relatively stable suffer smaller overruns than those which are highly volatile. The stability or volatility of contracts is characterized by their change history. A contract which is modified frequently or by large amounts is more unstable, or volatile, than one which is not changed either as often or by lesser amounts. This study attempts to find evidence supporting this common assertion by examining the relationship between cost growth and baseline stability on over 400 Major Defense Acquisition Program contracts over the last 26 years. The results are intriguing because, counter-intuitively, no significant evidence is found. Possible explanations and implications of this discovery are provided.

Leslie M. Norton Pride in Excellence Award (Outstanding quality) (four recipients)

Title: *Integration of the Distribution and Repair in Variable Environments (DRIVE) Model Into MICAP Policy*

Author: Captain Bradley E. Anderson (AFIT/GLM/LAL/96S-1)

Advisors: Lieutenant Colonel Jacob V. Simons, Jr. (LAL) and Lieutenant Colonel Terrance L. Pohlen (LAL)

Sponsor: Headquarters Air Force Materiel Command, Wright-Patterson AFB OH 45433-5006

This study explores different levels of DRIVE implementation in proposed asset release policies to help clarify which policy could best support Air Force weapon systems. The research used the Uniform Material Movement and Issue Priority System (UMMIPS) as a baseline for comparison with five levels of DRIVE implementation. The results yielded evidence that DRIVE utilization increases both overall aircraft availability and availability for bases with a Force Activity Designator (FAD) of two, while FAD one locations saw only a marginal decline in availability rates. Although greater DRIVE implementation than current policy did not yield better results, pure DRIVE utilization performed as well as current operating policy, and better than UMMIPS logic. The research results provided evidence that the latest HQ USAF/ILSP proposed asset distribution policy would produce worse results than current operating policy. DRIVE's asset distribution decisions produced the best overall results within the scope of this research, and warrant further study for even greater understanding of DRIVE's capabilities and limitations.

Title: *Does a Rubber Baseline Guarantee Overruns?* (A Study of Cost Performance and Contract Changes in Major Defense Acquisition Programs)

Author: Captain James A. Gordon (AFIT/GSM/LAS/96S-5)

Advisors: Dr. Dave S. Christensen (LAS) and Richard Antolini (LSQ)

Sponsor: Office of the Under Secretary of Defense (Acquisition), Washington DC 20301-3020

(See AFIT Commandant's Award)

Title: *An Exploration of Environmental Technology Transition from the Laboratory to the Field*

Author: Captain Michael A. Greiner (AFIT/GCA/LAS/96S-7)

Advisors: Major Richard M. Franza (LAS) and Lieutenant Colonel Steve T. Lofgren (ENV)

Sponsor: Armstrong Laboratory, Environics Directorate, Tyndall AFB FL 32403-5323

Environmental policy, social factors, individual behavior, and environmental technologies are key factors in improving the current condition of the environment. The Department of Defense (DoD) is not immune to these aspects, as its actions have and will continue to impact the environment in which they conduct operations. The objective of this research is to analyze the environmental technology aspect of improving environmental conditions. Of particular interest, what barriers and bridges are encountered when an Air Force laboratory transitions

environmental technologies to an end-user (operational field organization or major weapon system). The research employs a case study methodology to analyze five environmental technology transition efforts within the Air Force. Several key findings identify barriers and bridges specific to the transition of environmental technologies. They include: oversight of environmental protection agencies, the difficulty in clearly defining the end-user, and the need to demonstrate environmental technologies to potential end-users. Further analysis of the case studies indicate that many of the barriers and bridges encountered in the transition of environmental technologies are also encountered in the transition of general technologies. In addition, the researcher provides recommendations for change and offers future opportunities for research in the area of environmental technology transition.

Title: *Calibration of the CHECKPOINT Model to the Space and Missile Systems Center (SMC) Software Database (SWDB)*

Author: Captain Karen R. Mertes (AFIT/GCA/LAS/96S-11)

Advisors: Daniel V. Ferens (LAS) and Dr. Dave S. Christensen (LAS)

Sponsor: Management Consulting and Research, Inc., Thousand Oaks CA 91362

This study analyzed the effect of calibration on the performance of the CHECKPOINT Version 2.3.1 software cost estimating model. Data used for input into the model were drawn from the fiscal year 1995 USAF SMC Software Database (SWDB) Version 2.1. A comparison was made between the model's accuracy before and after calibration. This was done using records which were not used in calibration, referred to as validation points. A comparison of calibration points, both before and after, was done in order to assess whether calibration results in more consistency within the data set used. Six measures such as magnitude of relative error (MRE), mean magnitude of relative error (MMRE), root mean square error (RMS), relative root mean square error (RRMS), the prediction at level k/n, and the Wilcoxon Signed-Rank Test were used to describe accuracy. The results of this effort showed that the calibration of the CHECKPOINT model can improve cost estimation accuracy for development effort by as much as 96.71%.

National Contract Management Association (NCMA) Award (Significant contribution to contract management techniques)

Title: *Commercialization and the Small Business Innovation Research Program (SBIR): An Examination of the Impacts of Commercialization on the Small Businesses' Ability to Provide Research and Development Innovation to the Department of Defense*

Author: Captain Jennifer J. Thorpe (AFIT/GCM/LAS/96S-7)

Advisor: Major Richard A. L'heureux (LAS) and Dr. David K. Vaughan (LAC)

Sponsor: Headquarters Air Force Materiel Command, Science and Technology Division, Wright-Patterson AFB OH 45433-0336

This research explored the small businesses' perceived ability to provide goods and services to the Department of Defense through the Small Business Innovation Research (SBIR) program. The research was sparked by the enactment of Public Law 102-564, which increased the emphasis in commercialization as a basis for contract award and required a business plan to demonstrate commercial potential and third-party funding commitments. Five SBIR participants in the acquisition of Air Force research and developments innovation were investigated through case-study methodology. The research concluded that although the defense industries recognized the cumbersome nature of government procurement, they are eager to provide recommendations that may enhance the effectiveness of the program. The research findings also suggested that the Government periodically solicit the perceptions of small business participants prior to making policy changes to ensure the impact of those changes is not contrary to the intent of the program. Finally, the research uncovered issues that impact small business participation in the program. Additional research into these issues may further improve the efficacy of the SBIR program which promotes technology transfer through the use of small businesses.

Project Management Institute Thesis Award (Clear understanding and command of project management techniques)

Title: *Does a Rubber Baseline Guarantee Overruns?* (A Study of Cost Performance and Contract Changes in Major Defense Acquisition Programs)

Author: Captain James A. Gordon (AFIT/GSM/LAS/96S-5)

Advisors: Dr. Dave S. Christensen (LAS) and Richard Antolini (LSQ)

Sponsor: Office of the Under Secretary of Defense (Acquisition), Washington DC 20301-3020

(See AFIT Commandant's Award)

Society of Cost Estimating and Analysis Award (Significant contribution to cost analysis, cost estimating, or contract pricing techniques)

Title: *Calibration of the CHECKPOINT Model to the Space and Missile Systems Center (SMC) Software Database (SWDB)*

Author: Captain Karen R. Mertes (AFIT/GCA/LAS/96S-11)

Advisors: Daniel V. Ferens (LAS) and Dr. Dave S. Christensen (LAS)

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(See Leslie M. Norton Pride in Excellence Award)

Blood, Sweat, and Tears—A Different View of Logistics in the Republic of China

Colonel Te-Lung Tsai, ROCAF

Those that have studied the affairs between the Peoples Republic of China (PRC) and the Republic of China (ROC), as they related to the United States' and other industrial countries' political policies during the 1980s, must draw the conclusion that the ROC had little choice other than to develop their own defensive fighter program. With the military imbalance between the PRC and the ROC growing at a significant rate, the ROC was faced with a painful decision. In order to maintain control of ROC airspace, the ROC had two basic options. The ROC could procure existing second generation fighters from other industrial countries or develop and manufacture a second generation defensive fighter of their own. In the past, the ROC could expect assistance from the US in procuring defensive weapons systems for the ROC Air Force (ROCAF). However, with the changing political winds of the time, the ROCAF found itself without a valid path by which adequate weapon systems could be obtained. Thus the decision for the ROC to design and manufacture their own defensive fighter was born.

Though the growing pains and lessons to be learned from such an endeavor may have been underestimated, as the Chief of Program Control for the Indigenous Defensive Fighter (IDF) for the ROCAF Headquarters, I had a front row seat during this unique development effort. Because of my insight into this program, I felt it only fair that a different view of this program be presented. This paper will document some of the more intimate viewpoints of this program and present a realistic opposition to the article entitled "The Logistics of The Republic of China—A Clash of Cultures," which was published in the Winter 1996 edition of the *Air Force Journal of Logistics*.

Introduction

The ROCAF, the IDF's end user, did not have the luxury of participating in the program in a full time fashion until it entered the full scale development (FSD) phase. This was due to the program being managed at the National Council level in its early phase. In addition, the developer, the Chun Shung Institute of Science and Technology Aeronautical Industrial Development Center (CSIST/AIDC), a government funded science and technology agency which was over seen by the Ministry of National Defense (MND), was hoping to own the entire sovereignty of the program. However, the ROCAF decided to step in to assure the end users expectations would be incorporated into the IDF. This decision was made with the full knowledge that neither CSIST/AIDC or the ROCAF had the total experience required to ensure a smooth transition from FSD to production for such a program as the IDF.

In this early phase of the IDF's program, major constraints were identified and understood. Specifically, the inexperience

of the overall program management functions, coupled with a decision to complete the FSD portion of the program while allowing limited production, caused the risk profile of the IDF program to be high. Likewise, the development of a complete Logistic Support Analysis (LSA) package and Integrated Logistics Support Plan (ILSP) being developed during the same period added additional confusion to the program. However, after a brief demonstration and validation (D&M) phase, in which FSD was completed and limited testing allowed problems to be identified and corrections made to the production effort, the IDF now proudly protects the skies of the ROC.

It goes without saying the gestation period of the IDF was initially fraught with conflict between the ROCAF and CSIST/AIDC. However, no matter how vicious the hand-to-hand combat between these two agencies was in the beginning, it should be noted both sides joined forces and strove to develop and field a weapon system capable of defending their home land. The ROCAF, CSIST/AIDC, American advisors, scientists, and technicians paid the price of separation from family and home to overcome severe obstacles during the IDF's development and production phases. Some even paid the ultimate price to ensure this program would be a success.

The Chinese Culture And Face Saving As Compared to the IDF Program

The article stated that the Chinese people are prone to giving first priority to his or her own agenda over other things such as families, relatives, nation, and lastly to the program one is working. This could not be further from the truth if it was directed toward the IDF program. By way of illustration, when traveling to the headquarters of CSIST, one can find two commemorative rocks in front of this building. These rocks have two Chinese scientists' names engraved on them. Both of these men gave their lives to the program. Both, like many others on the program, felt dedicated to providing the best they could for the benefit of their country. Because they drove themselves both day and night in pursuit of providing the best effort possible, their health deteriorated to the point of total collapse and led to their eventual death. These men placed the interest of their nation above family, job, or self interest. They did this because they knew a strong nation provided the best vehicle to obtain safety for not only their families, jobs, or self interests, but for all the people of the ROC.

The article also concluded that the results of the investigation for the crash of an IDF during a Demonstration, Test, and Evaluation (DT&E) flight were meant to be covered up because a "loss of face" would occur if the truth were known. It further implied the problem still exist in the flight envelope of the IDF. Once again, I feel the article leaves an inaccurate perception of

the Chinese culture. To illustrate this point, the test pilot that identified the flutter at high speed and low altitude was instructed to eject from the unstable aircraft. However, the pilot elected to stay with the aircraft for as long as possible so as to collect as much data as possible which could be used to identify and resolve the problem. Again, the pilot put the nations needs before his own interest and safety. As a reward for his efforts, he unfortunately paid the ultimate price for the knowledge gained. Another test pilot, attending school in the US, requested permission to terminate his studies so as to be able to complete the testing and identification of the problem within the flight envelope of the IDF. Because of his efforts and self-sacrifice, the "hole" in the flight envelope of the IDF was identified and corrective actions were implemented. These corrective actions included a redesign of the horizontal tail, manufacturing changes to the flaperons, incorporation of the Sea Water Activated Release System (SEAWARS), and Auto Life Vest Inflation (ALVI) capabilities. It should be made clear that no competent pilot would fly any aircraft with an unexplainable life endangering flight envelope regardless of whose face he would be saving! Because of these pilots efforts, the ROCAF was proud to announce the IDF's flight envelope had been proven and continues to be further evaluated and expanded.

Within the decision making process of the corporate and military structure of the IDF program there exists dedicated leadership, organizational goals, consensus of those with ownership in the process, and support of these goals by subordinates. However, this does not mean professional disagreements were totally absent from the program. But, coordinated and deliberate decision making was always a requirement.

Having said this, in every rapidly advancing program, quick decisions based on heavy schedule pressures had to be made. Not all of these decisions had the luxury of allowing for team consensus to be reached. In these cases, the IDF Program Manager had to determine the eventual risk to the overall program and make a judgment call as to what must be done. This process is in direct contradiction to the statement in the article that "Decisions are deferred as long as possible since making no decision is less risky than making one which might be wrong and incur a resultant loss of face." As I have tried to show, decisions should be made based upon information. Decisions should be deferred if more information is required. These practices are among the basic practices of any executive. This practice does not differ from any other country's effort to ensure adequate team building tactics or basic prudent actions occur. It is neither a "face saving" problem or even remotely related to cultural practices. Afraid of losing face is the backbone of being responsible to the Chinese people and is not an excuse used to hide the truth.

I feel it would be wise for one to hold their conclusions about "Chinese unique culture and face saving" as it reflects the bumpy ride of the IDF development when given limitations such as inexperienced managers, overlapping FSD with production, indistinct operational requirements, and political limitations. This thought process is made even clearer when one compares the IDF development effort to those countries with much more experience in the design and development of new weapon systems, such as the US's A-12 Revenger or F-22 programs.

Both of these programs have experienced "growing pains." In fact, the A-12 program was canceled because of many of the same problems identified and overcome within the IDF's development effort.

Culture—A Thing To Be Treasured

Chinese who practice Buddhism believe in ghosts and offer worship to the dead. This belief can be seen in many ways such as Ghost Month, worshipping at temples, and burning ghost currency for the dead during funeral services. These basic beliefs inspire people to be good and differs little from the belief in God intrinsically because they are all bound from the evolution of human histories. Culture, the footprint of our ancestral heritage, is a subject to be treasured.

The facts indicate the IDF incorporated the latest scientific and computerized technology available to the ROC. One would have to be very narrow minded or brusque to insinuate that one single ghost belief incident like the burning of a flight suit for the pilot so he would be able to wear it in another dimension could be related to the difficult times experienced during the development of the IDF. This culture has existed for thousand of years and is a fundamental part of being Chinese. Many of the Chinese beliefs are no more absurd when they are compared to Westerners beliefs like Halloween or Friday the 13th. Burning of a flight suit was an act that was done out of friendship and culture.

What Ever Happened To Business Ethics?

The United States Air Force would never knowingly select an inexperienced system supplier for their aircraft development program. However, the IDF program was extremely limited in their selection process for system suppliers. Unfortunately, politics played a heavy role in the IDF development effort. For the air-to-air radar and engine systems, two of the most critical subsystems of the IDF, the Department of State Arms Control Act for export licenses made the selection of desired US suppliers and systems difficult. In addition, limitations for radar specifications as well as engine thrust performance was predetermined and confined by the export licenses. These limitations placed a ceiling cap as to how much mission capability could be grown in later update efforts.

In addition to imposed limitations, the original preselected radar vendor ultimately lost the contract because the losing vendor filed complaint after complaint with the US Government until the awarded contract was overturned. These external pressures made the job of finalizing contracts extremely difficult for the AIDC and ROCAF. The engine related limitations imposed "up front" identified risk for the IDF program. However, through thoughtful management practices, this risk has been mitigated to a low status.

It is true that the radar and engine programs might have involved business ethical concerns. However, when all the facts are applied, one cannot help but derive that those ethical business issues were unlikely caused by the Chinese side of the equation.

Test and Evaluation Of The IDF

The developer, AIDC, conducted the DT&E to the IDF whereas the user, ROCAF, performed the operational test and

evaluation (OT&E) efforts. Combination of these T&Es was also made in order to expedite the specifications, operational effectiveness, and suitability checks for all systems. This effort was made to assist in the decision making process of the IDF. Reporting channels and formats were established, inputs from the US advisors were solicited, and watch item systems for tracking improvements were made. It was true that not all of the advisors recommendations were adopted. However, this was usually related to resources constraints. Propulsion upgrades, for example, were a catch 22 to both the ROCAF and the AIDC. Improvement to propulsion netted a direct loss in mission capability in terms of combat radius. This was caused by the internal fuel capacity constraints, limited to an F-5 combat load, as defined by the Department of State Arms Control Act.

As I mentioned before, there were several conflicts between the AIDC thought process and the ROCAF thought process involving operational considerations to meet the users requirement. AIDC was geared to test only the specification of the IDF and advertise their achievement to meeting those specifications. However, the ROCAF felt the specifications did not meet the users requirements. To resolve this issue, the ROCAF redefined the requirement of the IDF via an Operational Requirement Document (ORD). This document brought about a major conflict between the ROCAF and the AIDC. This stemmed from the ORD's ability to define the users expectations.

These expectations were not solely identified by the specifications. This issue rapidly became a thorn in the side of the AIDC. The emerging conflicts revealed the facts that the T&E phase was not at all a "face saving" endeavor. Nevertheless, both DT&E and OT&E were used to define problems and identify fixes for the IDF.

Conclusion

IDF has cut back its initial production quantities after the F-16 procurement effort was awarded. It is true that the IDF is no longer the only focus for airspace superiority within the ROCAF, but the lessons learned during the IDF development have paved the way in establishing a fundamental process for weapon system acquisition for the ROCAF and AIDC. Though the IDF program was somewhat unique in its development characteristics, it was not unique in terms of the culture involved. It, like anything worth learning to do well, involved the blood, sweat, and tears of a nation trying to maintain the freedom and international recognition it deserves.

In quoting a well known American commentator, Mr. Paul Harvey, "And now you know the rest of the story."

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(Continued from page 30)

Virginia; Scott AFB, Illinois; Maxwell-Gunter AFB, Alabama; Peterson AFB, Colorado; Ramstein AB, Germany; and, Hickam AFB, Hawaii.

Approximately half of these positions become available for fill each year. Candidates apply in July, nominations are received in November, and interviews and selections are made in February and March. This provides selectees reasonable notice to make necessary personal arrangements for the forthcoming permanent-change-of-station (PCS) and for reporting to their new assignment by June. This permits the program to be more sensitive to employee and family needs, particularly those families with children in school. Registrants applying for career broadening positions must agree to be placed at any available location. This new single selection cycle sensitizes the selection process to employee needs while at the same time meets those of management in a timely manner.

Each career broadening cycle is advertised via message to senior logisticians and a condensed version is sent to civilian personnel offices. The message contains all necessary information needed to apply for the program. The competition is keen, with each applicant requiring the endorsement of their respective senior logistician. Applicants must register in the career program with a specific geographic availability code (GEOLC) representing the grade level they are interested in.

Qualifications for a career broadening assignment include: having a permanent grade of GS-11 or higher; being registered in the Logistics Civilian Career Enhancement Program (LCCEP); meeting basic eligibility for the GS-346 occupational series; having a minimum of five years of continuous federal service at any grade; being currently assigned to a logistics position, (an

LCCEP primary or shared occupational series); being currently assigned to a position with a logistics organizational function code; having a current overall performance appraisal rating of fully successful or higher; having one appraisal rating of excellent or superior within the past three years; and not have received an appraisal rating of less than fully successful during the same period. Applicants must have a minimum of three years experience in one or more logistics primary or shared occupational series as identified in the current Air Force Career Program's *Quick Reference Guide* which is available in the servicing training office or Civilian Personnel Flight. Only one LCCEP career broadening assignment is authorized per individual.

Registrants applying for career broadening must update their geographic availability on AF Form 2675, Registration and Geographic Availability, using the following codes: "ZZLNCB" for grades 12, 13, and 14; "ZZINCB" for grades 13 and 14; or "ZZFNCB" for grade 14. The geographic availability code permits candidates to indicate whether they are interested in reassignment or promotion. All promotions are temporary and candidates selected for career broadening are required to sign a mobility agreement as a condition of their selection.

Registrants making a competitive certificate issued for a career broadening position who subsequently decline consideration or selection are penalized with non-referral for other career program positions for a period of 6 or 12 months respectively.

Applicants may telephone the Headquarters Air Force Personnel Center (HQ AFPC) Call Center at 1-800-558-1404 to obtain their status regarding the current career broadening cycle. (Dana Chryar, HQ AFPC/DPKCLR, DSN 487-6464)

AIR FORCE LOGISTICS SYMPOSIUM 1997

Sponsored by the Air Force Logistics Management Agency

**Hosted by the Air Force Institute of Technology,
Graduate School of Logistics and Acquisition Management**

Wright-Patterson Air Force Base, Ohio

14 - 16 April 1997

Theme: The 1997 theme is "The Future of Air Force Logistics—New Directions to Support the Warfighter," reflecting the new emphasis on logistics in the Air Force Chief of Staff's Global Engagement philosophy, as well as the changing nature of Air Force doctrine since the end of the Cold War.

Topics: The areas of concentration for the symposium include: logistics doctrine, wholesale logistics processes, outsourcing and privatization, and modeling and simulation in logistics.

Speakers: The event will host a variety of experts in the field of logistics who will participate in moderated panel discussions regarding the implications of the changing logistics environment. The symposium will host speakers from the Air Force and civilian logistics community, as well as joint and international logistics speakers. These speakers will relate findings of recent logistics research efforts for debate and discussion.

Attendees: Attendance is open to both the government and the private sector. However, register early due to limited capacity at the symposium location.

Contact the following for further information on the symposium and registration: Captain Stella Smith, (334) 416-4581, DSN 596-4581, e-mail: ssmith@aflma.gunter.af.mil, or Captain Tom Snyder, (334) 416-4085, DSN 596-4085, e-mail: tsnyder@aflma.gunter.af.mil.

Registration Form (May be copied)

First Name: _____ **Last Name:** _____ **Rank/Grade:** _____

Business Address: _____

City: _____ **State:** _____ **Zip:** _____

Organization: _____

Phone: _____ **FAX:** _____

E-mail: _____

The symposium registration fee is \$60.00. Checks should be made payable to SIDAC.

Registration form and
check should be mailed to:

AFLMA/LGM
Attn: Capt Smith
501 Ward Street
Maxwell AFB, Gunter Annex AL 36114-3236